THE TELEGRAPHIC JOURNAL AND

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THE ILLUMINATION OF THE FLEET.

A GREAT deal has been written of late concerning the immense changes which have been effected in connection with the British Navy during the past half century, but little public attention seems to have been attracted to the transcendent importance attaching to the introduction of electricity in all its varied forms to meet the marine requirements of modern warfare. The *Inflexible* of to-day differs from the old *Victory* of Nelson's time, not solely on account of her immense bulk (of which much is concealed under the water-line), her powerful machinery making her independent of wind or tide, her gigantic armament, one well-directed shot from which would almost suffice to sink a three-decker of the old school, or her immense power of resistance, which would enable her to treat a whole broadside from the flagship of Trafalgar as though the guns were so many peashooters. The modern man-o'-war possesses many internal advantages which were never dreamt of, still less realised, eighty or ninety years ago, and without them the fighting craft in this year of Grace would be nothing better than floating prisons. At any rate, the "old wooden walls" had their decks open to receive the light of day, but it is not so with vessels of the *Inflexible* class. These floating, steel-girt fortresses, are submerged as far as they can be consistently with safety and stability, and if their submarine depths were illuminated with no more penetrating rays than those proceeding from dull and dispiriting lanterns, the seaman of the latter end of the nineteenth century would be doomed while at sea to spend his leisure hours amid the darkness of a dungeon. Fortunately, however, the transition from sails to steam, from wood to steel, from broadside vessels to turret ships, all but under water, has been accompanied by the development of electric lighting, which is now used on board all our large men-o'-war, except those of an obsolete type, contributing vastly to the comfort, convenience, and safety of all on board, and enabling even the powder magazines to be beautifully lit without the slightest fear of an explosion. Then there are the electric search lights carried by every ship of any size in the service, without which a big vessel like the *Inflexible* would be at night time completely at the mercy of any little torpedo boat which chose to assail her, while the use of electric currents enables torpedoes and submarine mines to be exploded at the will of an operator in the distance. The myriad of visitors who swarmed into our greatest naval port on Saturday to witness the splendid pageant at Spithead were enabled to draw their own comparisons between the *Victory* in Portsmouth Harbour and the *Inflexible* occupying the position of honour in the far-famed roadstead, and when at night the illumination of the fleet was in full swing they had an ample opportunity of observing for themselves the difference between the old method of lighting our ships and the new. During the day the weather had been simply delightful, the sun shining brilliantly the whole time the review was proceeding, but after sunset, owing perhaps to the heat of the day a slight mist arose, which somewhat bedimmed the brilliancy of the immense array of coloured lamps, with which the old line of battle ships in the harbour were festooned. On the other hand, this unfavourable change in the elements served admirably to demonstrate the wonderful penetrating power of electric lamps when compared with that of any other light. For over an hour serried masses of spectators assembled on the shores of Southsea, Stokes Bay, and the Isle of Wight, craned their necks to catch as uninterrupted a view as possible of the splendid illumination, principally by means of electricity, of the fleet in the roadstead. The fine line of troopships, which formed a fourth division by themselves, threw open their portholes, from which shone the brilliant light of the incandescent lamps with which all the decks are fitted. Owing to the murky weather, the effect of the dressing of the ships in rainbow fashion by means of coloured lamps was somewhat spoiled, but the incandescent lights which formed the monogram V.R. on a black background showed up remarkably well on each ship, lighting up splendidly the fore and main masts, between which they were triced. Then the search lights—there were four on some of the biggest ships—penetrated the lowering mists, and from the spectators came quite a spontaneous cheer when the various lights were so arranged as to form luminous arches in the sky. With remarkable effect, too, the search lights were concentrated on different points ashore and afloat, and where complete darkness had prevailed a minute or two before there came a sudden flood of light which threw the scenery into relief with almost microscopic detail. On the whole the spectators saw much to impress them with the power and utility of electricity.

EITHER the President of the United States does not appreciate the telephone at its full value, or he has resolved to submit to inconvenience in the interests of economy. The Government telephone contract having expired, he gave the company the option of reducing its charge by $20 a year for each telephone or removing the instruments altogether. The company has decided upon the latter course, and has shown commendable courage, we think, in doing so. The Government probably has its telephones at quite as low a rate as other subscribers; the company bases its charges upon the principle of deriving a profit upon each instrument rented, and to reduce the charge to one subscriber would be to act unfairly towards the others.

A HEARTY welcome to the *Western Electrician*. This new journal comes to us from Chicago, where must be an immense field for electrical journalism. The contents and arrangement of the *Western Electrician* afford evidence of editorial discrimination, and a bold warn-

ing is given that no effort will be spared to place the paper, not merely in the front rank, but in the lead. The development of the West in all respects has been proceeding by leaps and bounds during the last decade, and nowhere has greater progress been made in the utilisation of electricity during the 18 months just past. Our new friend, therefore, has a future full of promise, and we hope to see it shortly realising some of its high hopes.

NOTWITHSTANDING the fact that we have this week added an additional 16 columns of reading matter, we are still compelled to leave in abeyance the further "Examination Questions" which we had hoped to publish in this issue. The continuance of the articles on "Electricity applied to Railway Working" has also to give place to that which overshadows *pro tem.* all else, viz., the proceedings in connection with the Jubilee of the Electric Telegraph, a full report of which is contained herein.

Money thinks that D'Humy's primary battery, whose principal element is said by our financial contemporary to be mainly composed of *aqua pura*, presents a combination of advantages which have not been before attained in any single invention. The following description is edifying in the extreme:—"The negative element of the battery is carbon immersed in nitric acid, and the positive, iron immersed in water, and the latter becoming acidulated by the percolation of the nitric acid through the porous diaphragms separating the stronger from the weaker solutions, the result is an electromotive couple of great efficiency. These cells may be short circuited with but little polarisation, and consequently show a high electromotive efficiency in relation to the internal resistance of the cell. Nothing but the addition of water to the outer cells is required to maintain the action of the battery; the cost of renewals is almost nil, while the battery possesses the further advantage that no skilled labour is required for its manipulation. It is pointed out, also, that one lamp of 10-candle power will yield an amount of light at a cost which will show a profit of 18s. 6d. per annum on every such lamp, the consumer being charged at the present rates for gas. Mr. D'Humy possesses both the English and foreign patents for the battery, and it is intended to form a public company to work the invention." We should be the very last to throw cold water on any meritorious invention, but we want to know more of the D'Humy battery which, if we are not mistaken, has been in course of development for some years, before we could say, as Prof. Thompson did of the Eclipse, "there's money in it."

THE business of Messrs. Woodhouse and Rawson, which has for some years taken a leading position in the electrical world, is now in the course of formation into a limited liability company with a capital of £200,000. It is well known that for something like two years Mr. Woodhouse has been compelled, through failing health, to abstain from all active participation in a business which has seemingly developed into proportions too large for one individual to thoroughly supervise, and the decision to turn the business over to a company appears warranted. The special features which Messrs. Woodhouse and Rawson have introduced into electrical work of all kinds need no comment from us for they are familiar to all readers of the ELECTRICAL REVIEW, and the prospectus of the new company which appears in our trade columns will afford information respecting the future developments which are anticipated. The only item in the projected scheme which appears to us to call for any remark is the sum estimated by "a well-known expert" as the value of patents and patent rights. It would be interesting to know what the patents are, in which the firm is interested, whose value in these days can be set down at £151,000; this, however, is not a matter of great public importance in the case of a company whose capital is already largely taken up, and we refer to it only as our thoughts turn to a paragraph in the prospectus which partly attributes the failures of many companies to the large sums paid for patents. It will be noticed that Mr. Rawson is retained as managing director for a period of not less than five years, and his past experience should assuredly be instrumental in securing for the company such a share of public patronage as to warrant the founders in practically staking their acquired position and profits upon its future success.

AFTER a delay of several weeks Mr. Elieson has again recommenced operations on the Stratford Manor Park tramline. On Monday one electric locomotive was started and has since been running satisfactorily; on Monday next another will be put on the track, and in the following week a third will be added. We trust that nothing will again transpire to upset the working of these locomotives, for many people are awaiting with much interest the result of the trials which should be the means of developing electrical traction in this country on a large scale.

THE promoters of the Paris-Brussels telephone line are determined that the people of the two towns shall have the full benefits of the connection. The service has hitherto been limited to messages between the two exchanges, but all the subscribers to each exchange are now to have facilities offered them for making use of the line. This will be a great extension of the usefulness of the system, and we expect to hear that it is appreciated.

THAT the telephone is not necessarily inimical to the telegraph is shown by the remarkable increase which has taken place in the number of telegraphic messages forwarded by telephone between telegraph offices and private establishments. Statistics are before us which show the results of the facility given to telephone subscribers for sending telegrams in Belgium. During the first five months of the present year 167,838 telegrams were so transmitted on the Brussels, Antwerp, Liège, Charleroi, Ghent, Verviers and Louvaise lines, this being an increase of 37 per cent. over the number sent in the corresponding period of 1886. Throughout Belgium it is estimated that there is an average of 1,200 telephonically transmitted telegrams per day.

WHAT reason have the authorities of the Gloucester Infirmary for the churlishness which they have displayed in refusing the offer extended to them by the Western Counties and South Wales Telephone Company of the free use of the facilities of the Gloucester Exchange? Similar institutions in other towns have been quick to recognise the advantage of such connection and have gratefully accepted the boon. Pearls are not offered to the unappreciative every day, but the company will, we believe, give the Infirmary another chance.

EXPERIMENTAL ATTEMPTS TO OBTAIN ALUMINIUM BY THE DRY WAY.

By ALEXANDER WATT.

(*Continued from page* 76.)

19. In this experiment two mixtures were first prepared; one of these consisting of finely powdered kryolite and sand, intimately mixed, and the other of dried carbonate of soda and powdered charcoal. A layer of the latter mixture was placed at the bottom of a crucible, and well pressed down; above this was placed a layer of the kryolite mixture, which was also tightly compressed; a layer of soda and charcoal was placed above this, and the alternate strata were introduced in the same order until the vessel was nearly full, when a final stratum of China clay, was placed over all, and the crucible then covered by its lid; the vessel was then gradually heated to bright redness, at which temperature it was sustained for about an hour. On examining the contents of the crucible, after cooling, the presence of free aluminium was detected in the several strata, but not in sufficient quantity to render the trial significant.

20. In the next trial powdered kryolite and chalk, intimately mixed, were placed in alternate layers with the soda and charcoal mixture employed in the last experiment, the various strata being well pressed down in the crucible, and a final layer of China clay placed over all, as before. The crucible was then covered and heated gradually to redness only, the heat being sustained for about two hours. As in the previous case, traces of aluminium were found in each of the kryolite layers, but no globules of metal appeared.

21. Precipitated silica and powdered kryolite were substituted for the mixture employed in experiment 19, and placed in alternate layers with the soda and carbon mixture, in a crucible, and treated as before, the heat being kept low at first, but afterwards gradually increased to full redness. When cold the crucible was broken up, and its several strata examined. There was evidence of free aluminium in some parts of the different layers, but in very small quantities.

22. Kryolite, chalk, carbonate of soda and charcoal, all in fine powder and intimately mixed, were put into a crucible and well rammed down. A layer of kaolin was placed at the top, the crucible then covered, and gradually heated to redness; after a time the heat was increased to a bright red and kept at this point for about one hour. The resulting mass, when cold, yielded traces of aluminium, but there were no globules of the metal.

23. A quantity of caustic potash was put into a clay crucible and fused; iron filings were then added, and after a few moments powdered kryolite was introduced, a little at a time, and the heat increased until the latter substance became fused. After about an hour or so, jets of flame, of a green colour, appeared with great suddenness on the surface of the liquid mass, accompanied by a trifling sound; these jets occurred at long intervals, and continued to appear for a considerable time. In the result, a button of iron was obtained, the surface of which was somewhat whiter in some parts than others, while the bulk of the lump was exceedingly hard and close in texture; the result was not sufficiently marked, however, to be of any practical value.

24. Finely powdered kryolite, carbonate of soda, charcoal and sugar were worked up into a thick paste with a little water. The mass was then made up into small pellets or balls, and dried slowly. When thoroughly dry, the pellets were put into a crucible, which was then covered and heated very gradually, the temperature being augmented slowly until finally a bright red heat was obtained; this heat was sustained for about half-an-hour, and the crucible then withdrawn and allowed to cool. The pellets were now examined, and traces of aluminium were found in each of them, not, however, in any practical shape or quantity.

25. Sulphate of alumina was heated to redness, and afterwards reduced to a fine powder. To this was added dried and powdered ferrocyanide of potassium and fused and powdered chloride of sodium, in atomic proportions, the whole being intimately mixed together. The mixture thus formed was put into a crucible and heated to bright redness for about half-an-hour. There was no trace of aluminium in the result.

26. Silicate of alumina (kaolin), was mixed with dried carbonate of soda and charcoal, all in fine powder, and moderately heated in a clay crucible for about half-an-hour; the heat was then gradually increased to a bright red, and sustained at that temperature for about the same period. This experiment was not successful in any degree, for there was no trace of aluminium.

27. Kryolite, lime and charcoal, all in fine powder, were well mixed together and put into a crucible and tightly pressed down; a mixture of fused and powdered chloride of sodium and chloride of potassium was then placed over the top, and the crucible gradually heated to bright redness. When cold, the crucible was broken up, when a dull grey opaque mass appeared, which readily separated into four nearly equal segments, vertically. A small portion of the product was reduced to powder and tested, when the presence of free aluminium became very apparent. A larger quantity of the mass was next pulverised and introduced, a little at a time, into a crucible containing a fused mixture of the chlorides of sodium and potassium. Soon after the powder had been introduced into the fused chlorides, considerable intumescence supervened, while abundant sodium vapours were given off and copious bubbles appeared on the surface of the mass. After an hour or so, the crucible was withdrawn from the fire and allowed to cool. When cold, a pure white flux appeared upon the surface, and a greyish mass beneath, which, when tested, showed the presence of aluminium, but no globules of the metal, however, were found.

28. Powdered kryolite and kaolin, in about equal parts, were intimately mixed and then put into a crucible and heated. When approaching a dull red heat the mass assumed a pasty consistence, and as the temperature increased it gradually became more fluid, eventually becoming quite liquid at a full red heat. During the fusion there was considerable evidence of chemical action, and sodium vapours were freely given off, the upper surface of the liquid being covered with sodium flames. Acid fumes were also given off—probably fluosilicic acid. A small piece of coal was now immersed in the molten mass and allowed to burn away, when a second, and larger lump, was introduced; the crucible was then covered and the heat moderately increased. The result, however, was unsatisfactory, as there was but a slight trace of aluminium in the resulting product.

29. In a clay "skittle pot" was placed the following mixture in atomic proportions: kryolite, lime, carbon and silica, all in fine powder and well mixed. The crucible was then heated gradually, and when the materials had acquired a full red heat copper filings were introduced, a little at a time. Considerable chemical action took place, during which dense fumes escaped through the orifice of the vessel. After about an hour or so the pot was set aside to cool, and was subsequently broken up and the contents examined. The copper appeared in the form of globules, or beads, some of which had a yellow colour, but when tested for aluminium there was but trifling evidence of that metal having alloyed itself with the copper.

30. In this experiment it was determined to ascertain whether the fluorine of the double fluoride of aluminium and sodium would combine with the lime, forming fluoride of calcium, and thus liberate the metal, aluminium. For this purpose a quantity of finely powdered kryolite was carefully mixed with powdered chalk, and a little charcoal added, and the mixture then heated to bright redness in a covered crucible for an hour or so. The vessel was then set aside until cold, when it was broken with a hammer, and the vitreous contents examined. On breaking the mass by a smart blow of the hammer, a conical lump about the size and form of a filbert nut was discovered loosely imbedded in the bulk of the mass, and readily dropped into the

hand. This substance was afterwards examined, and proved to be fluoride of calcium. Portions of the surrounding mass were then tested for aluminium and its presence was discovered without doubt, but not in sufficient quantity to render the experiment practically successful.

31. Powdered kryolite, charcoal and lime—the latter in excess—were next tried, and heated to a bright red for about an hour, in a covered crucible. The resulting mass, when cold, was tested for aluminium, when traces of the metal were discovered, but not in a globular form. In these cases it is probable that the heat was not kept up for a sufficient length of time.

32. Calcined sulphate of alumina and powdered coal were intimately mixed and heated to bright redness, in a covered crucible, for fully an hour; the pot was then withdrawn and set aside to cool. Some traces of free aluminium were found in the product, but to no appreciable extent.

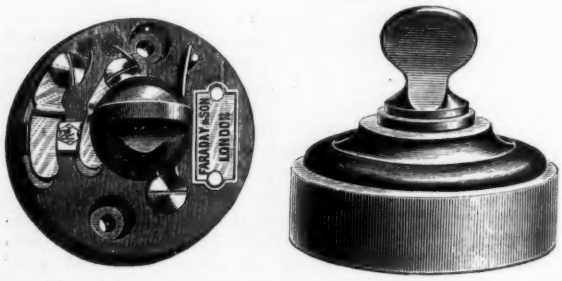
33. An attempt was made to reduce aluminium from its oxide by means of metallic zinc. Some lumps of zinc were put into a tall skittle pot, and above this was placed a quantity of alumina in fine powder, a layer of powdered charcoal being placed at the top. The crucible was then moderately heated, so as to allow the zinc to distil through the mass; the heat was then gradually increased to a full red heat. In the result, all the zinc was found to have volatilised, but no perceptible change had taken place in the alumina.

34. Brass, with an excess of zinc added, was next tried, to see if the zinc by passing more slowly through the red hot alumina would take the oxygen from it and liberate the metal. Such was not the case, however, for the zinc simply volatilised as before, leaving the alumina unchanged.

(*To be continued.*)

SWITCHES FOR INCANDESCENT LAMPS.

MESSRS. FARADAY & SON, of Berners Street, W., have just registered and brought out a switch designed by Mr. Howard Swan (of which we reproduce a sketch), who attempts to embody the following requirements:—A good switch must be simple and easily understood by workmen, impossible to get out of order, easy to wire and fix, and to inspect after fixing; and arranged so that the wires can come in conveniently near the upper edge. It should have large contacts, and double bearing surfaces in each, a quick break on



Top View, showing connections. *Side View.*

BRIDGING SWITCH.

turning off; and the electrical contact should be a pure electrical "bridge-over," *i.e.*, the circuit should not have to pass across joints of the moving parts, where oil and dust might add to the resistance; and it should be practically incombustible. In addition to this it must not be too mechanical in appearance, but should be finished as a piece of furniture, and yet be fairly cheap.

As will be seen from the sketch the action is simple and easily understood. The two double spring contacts are bridged across by the stout brass connecting piece when the handle is turned; a steel spring, which bears stifly upon a projection at the back of the connecting piece, in the manner of a knife-blade, gives a quick break on turning off.

The covers are turned in boxwood, rosewood, or are ebonised, suitable for use in house lighting. These switches, we are informed, have been tested up to 10 ampères, and are considered suitable for one to six lamps at 100 volts.

Messrs. Faraday have a spring shade holder which we also illustrate. This is designed to give a graceful finish to pendants and brackets, and at the same time provide an easy method of taking down the glasses to clean, superseding the usual thumbscrew arrangement. Inside the cap two half rings of spring wire encircle

FARADAY'S SPRING SHADE HOLDER.

the neck of the glass shade: by pressing together the crossed ends of these springs they widen, and release the shade. Pretty and convenient pendants can be made with simply these caps and a fancy glass shade, or, of course, they can be attached to larger electroliers or to brackets with similar convenience.

Faraday's "Sydenham" holder, which we described and illustrated in a recent issue, is now being made in a larger size, giving more room—$\frac{3}{4}$ inch—for the terminals.

THE ROYAL JUBILEE EXHIBITION, MANCHESTER.

EXHIBITS.—DYNAMOS.

IN describing the electric lighting arrangements of this exhibition, reference was made to the several kinds of dynamos utilised for the purpose, but the types employed have been so frequently described and illustrated that we do not propose to give any description of them, but only to mention the various types in use in the dynamo room at the present time. For the arc lighting the three types of the Brush dynamo, 15, 25, and 35-light are employed, 25 machines in all being fixed at the present time, operating 512 arc lamps. For the incandescent lighting there are two sizes of each of the Edison-Hopkinson 250 and 500-light machines; two Manchester, one 500-light Elwell-Parker, and four of the original 250-light Edison dynamos, and there has lately been brought into use a "Hall" dynamo for lighting one of the sections, a description of this is given later on. In the dynamo room there is also, as we have already stated, a "Manchester" generator working motors for Mather and Platt's exhibits. At the end of the machinery annexe there are also two large Siemens dynamos for the arc lights in connection with the fairy fountain. In the machinery annexe close to the dynamo room has been placed an exhibit of the Anglo-American Brush Corporation consisting of "Victoria" dynamos with engines attached, in one instance of some novelty. To this exhibit we shall refer in a subsequent article. The exhibit has only been put together in the last few days, the delay being due

to the fact that the allotted space was not ready. This space consists of a platform over the railway, opposite the boilers, above which was worked the travelling crane. This platform could not be constructed until some time after the exhibition was open.

Scattered over the machinery annexe are various dynamos mostly employed in exhibiting the electric light, but there is at stand No. 577 a small "Hall" dynamo attached to a "Günther" turbine, especially designed as a motor for dynamos and which we illustrate. This exhibit (not shown in motion) consists of two turbines, one with a driving pulley on the shaft, and the other working a "Hall" dynamo direct on a coupled shaft. Mr. Günther has devoted particular attention to turbines to be used in connection with electric lighting, and turbines have already been made by him for this purpose for falls varying from 3¼ feet to 200 feet.

Fig. 1 illustrates an improved suction turbine arranged with horizontal shaft for driving by belt or ropes. This turbine may be placed at any height—not exceeding 25 to 30 feet—above the level of the tail water, air-tight pipes connecting the turbine with both head and tail waters. The regulation or adjustment of the turbine is worked from the handwheel, and consists of a slide moving over the guide ports and opening or closing one port on each side simultaneously; this slide is also used for starting or stopping the turbine. Special provision is made for effectively lubricating all its bearings, while the footstop works in an oil chamber on a standard at the end of the bedplate, where it may be easily oiled or examined at any time. This turbine is adapted for falls from 5 feet up to 50 or 60 feet, and we are informed that Mr. Günther is now specially constructing a very sensitive turbine for the high fall of 105 feet, which will drive a 300-light dynamo direct—dynamo and turbine being fitted on the same frame—in a mill in Norway.

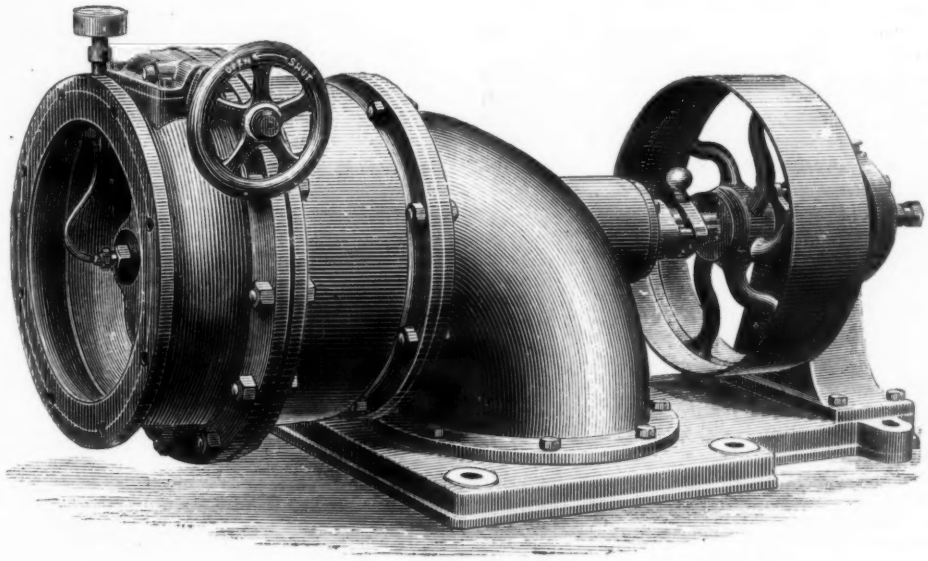


FIG. 1.

In fig. 2 is shown one of Mr. Günther's "Girard" turbines coupled direct to a dynamo for electric lighting. The turbine is adapted for high falls, from 100 feet upwards, and is arranged with partial injection. The water is admitted in the internal circumference of the wheel, and the single guide port is regulated by means of a gun metal slide, which forms the top of the port. By moving this slide up or down by means of a screw, worm, and wheel, and handwheel, the discharge of the port is increased or decreased as required. The turbine wheel, as is Mr. Günther's practice with high fall turbines, has the vanes of steel to secure greater strength and durability. The turbine shown is for a fall of 220 feet, being designed to suit the speed of the dynamo, which runs at 1,350 revolutions per minute.

The dynamo in fig. 2, which is the patent of Mr. J. P. Hall, of Oldham, is of a somewhat novel construction, although bearing an external resemblance to the Gramme "type supérieur," the field magnet, including the yoke and pole pieces, being cast all in one piece with the bed plate and supports for the pedestals. The shaft is of Bessemer steel, and the bearings, which are of large surface, are bushed with phosphor bronze. The commutator bars are of hard rolled copper and are insulated with mica, and the magnet is compound-wound. This machine is designed for an output of 35 ampères at 100 volts, with a speed of 1,350 revolutions per minute. The armature is of the Gramme type, and is built up on a brass frame of specially softened charcoal iron plates, well insulated from each other and from the frame, and is wound with 480 convolutions of a No. 15 B.W.G. wire, weighing 13 lbs., having 0·412 ohm resistance, the sectional area being 302 circular mils. per ampère, and the electrical loss 14·36 per cent. with full load. The series coils consist of 51 lbs. of a No. 7 B.W.G. wire having a resistance of 0·165 ohm, the sectional area being 926 circular mils. per ampère, and the electrical loss 5·77 per cent. with full load. The shunt coils consist of 45 lbs. of No. 20 B.W.G. wire with a resistance of 101·38 ohms, and having a sectional area of 1,242 circular mils. per ampère and an electrical loss of 2·74 per cent., the machine giving a total electrical efficiency of 77·13 per cent.

A turbine and dynamo of a precisely similar size are, we are informed, at work at a mansion in North Wales, where the fall is 161 feet. They have been working since November last year, and have given great satisfaction.

A "Hall" dynamo of considerably larger proportions has been fixed in the dynamo room, and is connected with a Hornsby high-speed vertical engine. This dynamo is of a capacity of 200 ampères with an E.M.F. of 110 volts, but at present it has not been put to its full load. The circuit connected with the lamps at exhibitors' stands in the "Irish" section and western nave has been diverted from one of the main incandescent circuits for lighting the dining rooms and Old Manchester, and connected on to this dynamo. At present there are on this circuit 150 lamps of 16 candle-power each. The load on this dynamo will, it is expected, be shortly increased, so that then we shall have an opportunity of judging its performances.

At stand 364 Mr. H. Bury, electrical engineer, of

Manchester, shows a small dynamo driven from the shafting in the machinery annexe and lighting up his exhibits very successfully. The lights are arranged in a very effective manner, and are utilised in connection with various fittings, such as brackets, shades, &c. The dynamo called the "Excelsior" has been manufactured by Messrs. Stanley and Davies, of Hyde, for Mr. Bury, but as it has only been placed in position during the last few days we cannot at present give details.

Messrs. Crossley Brothers, Limited, show, in connection with the Manchester Electric Supply Company (484, 484*a*) a vertical gas engine with Crompton dynamo combined. The dynamo lights numerous incandescent lamps, and at stand 355 Messrs. Crossley exhibit one 14 H.P. (nominal) horizontal gas engine, driven by gas made in the Dowson Economic Gas Apparatus (exhibited outside), and itself driving a Crompton dynamo, which is utilised for illuminating the stand with a number of incandescent lamps.

small Phœnix motor placed some distance away in the Irish section. This motor, which is neatly arranged, drives a special stamping machine with perfect ease. Situated as this exhibit is in the Irish section, and away from any shafting or power, it would have been necessary for it to have remained at rest unless the electromotor had been applied, consequently the utility of the exhibit can now be properly seen.

We draw our present notice to a conclusion with a reference to the "Luther dynamo" of Messrs. Hanson and Charles, for which some special advantages are claimed. The dynamo is compound-wound, with an output of 120 ampères and 65 volts, at a speed of 850 revolutions per minute, and it has been utilised for running a number of incandescent lights as well as a novel form of arc light. As the field magnets are composed of annealed charcoal iron wire wound on a soft cast iron shell, a complete magnetic circuit without joint in the direction of the lines of force is obtained, together with freedom from eddy currents. The pole pieces

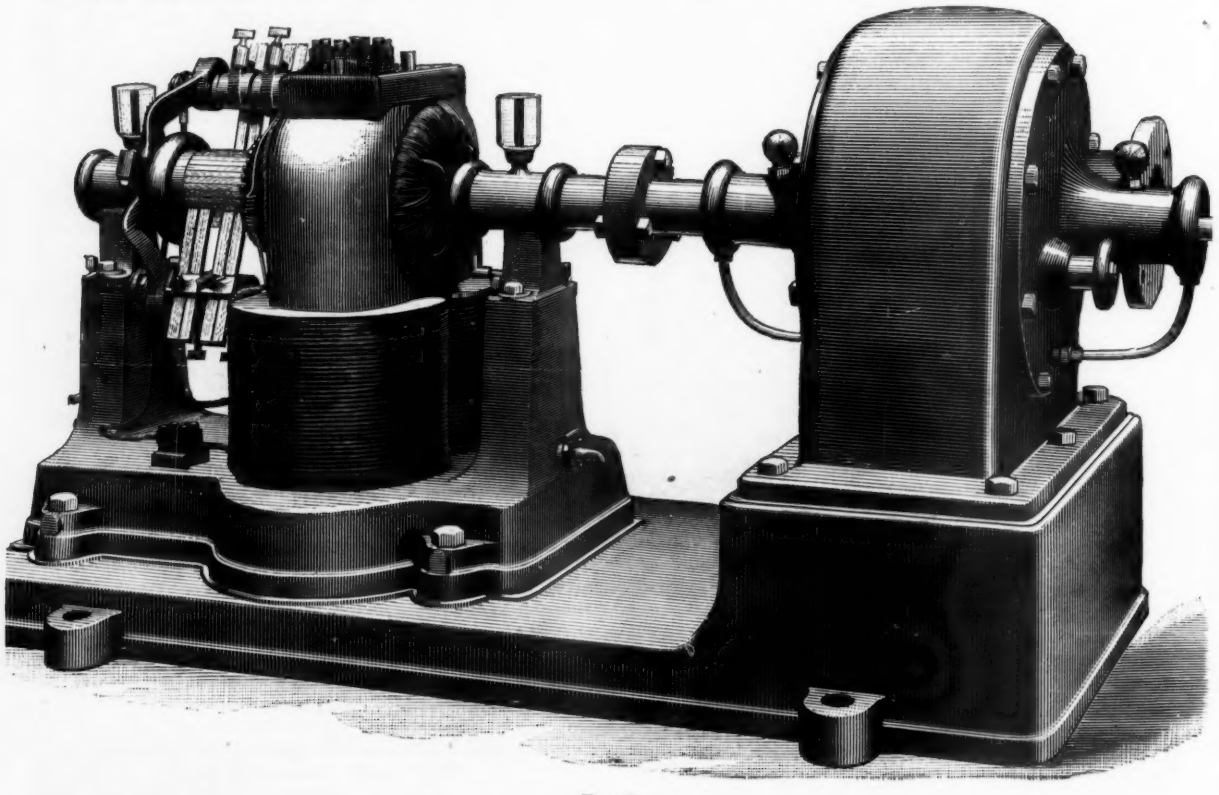


FIG. 2.

At stand 413 Messrs. Tangye's, Limited have a vertical engine driving a Crompton dynamo, and outside in the grounds in a small erection Messrs. A. Shirlaw & Co., of Birmingham, show amongst their exhibits a 2 H.P. (nominal) Spiel's patent petroleum engine, driving an Elwell-Parker dynamo and a small installation of about 30 incandescent lamps. Attention is especially directed to this exhibit, as the use of the "Spiel" engine supplies the power for driving a dynamo in situations where power of the usual kinds, such as steam, water, or gas, cannot possibly be obtained. The satisfactory working of this small installation with the "Spiel" engine has a great bearing on the future of such electric installations as have been up to the present rendered impossible from the want of power.

Messrs. Heenan and Froude, at stand 417, exhibit dynamos driven by their "Tower" spherical engine. The dynamos are two small ones of the Phœnix type by Messrs. Paterson and Cooper, they are used for lighting by incandescent, and also for Dick and Kennedy's arc lamps. One of the dynamos also acts a generator for a

and shell being one casting, no jointing or fitting is required. High efficiency is claimed in consequence of the field magnet core not being a solid mass, as usual in most dynamos, but perfectly laminated, and of such quality and softness by annealing not to be obtained by any other means than in the form of wire. By reason of the above construction it is claimed that a very powerful field is obtained with a small expenditure of electrical energy. In a future number we hope to describe more minutely this and some other dynamos.

Further Bank Lighting.—The fine premises of the Union Bank of London at the corner of Princes Street, are to be lit throughout with the electric light. The work has been given to Messrs. B. Verity and Sons, of King Street, Covent Garden, the installation having been designed by Messrs. Drake and Gorham, who have also been appointed electrical engineers to the bank. The installation will consist of upwards of 300 lamps, the necessary power being obtained from two 9 horse-power Otto gas engines.

THE ECONOMICAL DISPOSITION OF PRIMARY BATTERIES.

THE true action of a primary galvanic battery in some of its features is not generally comprehended, even by those familiar with the ordinary phenomena of electricity. The size of a battery, and the direct effects of varying it, and the deleterious effects of internal resistance, are among the factors least grasped. At the present day the error is sometimes made of supposing that the size of a cell affects its electromotive force, and internal resistance is often spoken of as a beneficial element.

Yet if the subject be brought down to facts, the case is a very clear one. The electromotive force is quite independent of dimensions, and a cell the size of a percussion cap will produce as high an electromotive force as the largest made. This, to many, sounds a truism, yet it is by no means universally realised. But on the subject of resistance a more firmly fixed misconception prevails to a considerable extent. It is often asserted that low resistance batteries are not wanted. The truth is that they are wanted, and that the invention of a non-polarising or constant and low resistance battery would be a valuable contribution to the resources of the electric engineer. The source of the error on the subject of resistance is doubtless due to the universal application of Ohm's law for fixing the number of cells in a battery for given external resistance.

By simple mathematical demonstrations it is proved that the most economical distribution of battery, as far as the number of cells is concerned, is attained when the internal, or battery, resistance and the resistance of the external circuit are equal. Thus with 10 ohms resistance on the outer circuit, enough cells should be provided to have the same resistance internally. This, however, refers only to the number of cells, and not to their economic working. This limitation is very generally overlooked. The arrangement of battery so as to make internal and external resistance the same is considered the ultimatum, and the low resistance of cells is held not to be a specific advantage.

The ordinary calculation of the number of cells required to supply a circuit may be used as an example. Suppose a difference of potential of 35 volts is to be maintained between the extremities of an external circuit of 40 ohms resistance, giving a current of 0·875 ampére, and assume each cell of the given battery to yield 1·75 volts with an internal resistance of 1 ohm. In making the calculation, it is at first taken for granted that the internal resistance of the battery must be 40 ohms. Therefore the total resistance to be overcome is 80 ohms, so that the effective voltage of the battery is reduced one-half. Dividing, therefore, 35 volts by 0·875 volt, the dividend 40 is the number of cells that must be arranged in series. Then, as these will have a resistance of 40 ohms, the problem is solved, and this is treated as the most advantageous possible arrangement. This it is far from being; it is the best arrangement of 40 elements in the given circuit. It contains the minimum number of elements that will maintain the given current through the circuit, but it is not an economical arrangement as regards consumption of material.

The battery in the case cited having exactly the same resistance as the external circuit, absorbs one-half of the current. One-half of the electrical energy disappears in forcing the current through the battery. This represents 50 per cent. of the chemicals and zinc which is actually wasted or spent on useless work. A battery run on this principle by no fair principle can be compared with a steam boiler, to settle the point of efficiency. It is doing only a shade over half the useful work that it is capable of. To compare the cost of a battery with any other prime generator, it must work under widely different circumstances from that instanced. Its difference of potential, and at the same time, its resistance must be lowered. This can be done by increasing the number of elements and arranging them in several parallel series.

The battery and circuit above cited having a resistance of 80 ohms with 70 volts difference of potential in the battery, maintains a current of 0·875 ampére. By arranging four such series of cells in parallel, the internal resistance would be reduced to 10 ohms, the total resistance to 50 ohms, and a current of 1·4 ampères would be produced. To reduce this to 0·875 ampère, four parallel series of 23 cells each would be required. This is an increase in cells. The total number is 92 instead of 40. But as the battery would only have one-seventh the resistance of the whole circuit, it would absorb one-seventh instead of one-half the electrical energy, thus indicating at once a saving of nearly 50 per cent. in consumption of zinc and chemicals. The limit of efficiency is approximated to by using a little over double the original number of cells.

In all applications of primary batteries to motors, this principle should be kept in mind. In storage batteries it has received a high development. They have such low internal resistance that it is treated as of no value, or as zero. Were they of high resistance, and were they used so as to possess within themselves one-half the total resistance, then, instead of developing an electric efficiency of 85 to 90 per cent., they would give a return of only 42½ to 45 per cent. of the charging current. Their constructors in order to obtain a commercial efficiency were obliged to construct them of low resistance. But the inventors of primary batteries having their minds fixed on other considerations, such as economy of space, rather than economy of material consumed, have overlooked the evil effects of high resistance.

The resistance may be reduced by bringing the plates closer together. In the primary battery the solution of a metal has to be provided for, and the difficulties due to the low rate of diffusion of liquids have prevented too near an approach of the plates to each other. In the storage battery this trouble is of course absent. But it is clear that in low resistance lies the hope for a future use of the primary battery for small powers or for electric launches. So many points tell in favour of the primary battery that it seems a pity that it cannot be more generally used. But it can never be economically employed if the minimum number of cells only is adopted as the basis of instalment.—*Scientific American.*

PRACTICAL ELECTRICAL MEASUREMENT.

By J. SWINBURNE.

(*Continued from page* 81.)

CALIBRATION OF VOLT AND AMMETERS—(*continued*).

The methods of calibrating voltmeters, described above, are suitable for makers of instruments, and most electrical engineers are in want of some more simple means of checking a voltmeter or ammeter to see if it is approximately correct. Most engineers have a Wheatstone bridge, generally of the Post Office pattern, a horizontal detector, and some voltmeters and ammeters.

It would be absurd to set up a set of little cells and make a number of carefully-measured resistances to see if the voltmeters and ammeters are correct. The first thing to do is to see if the voltmeter agrees with the ammeter. Suppose the voltmeter reads up to 120 volts, and the ammeter up to 50 ampères. A wire which will carry 5 or 6 ampères without heating perceptibly is taken, and, say, 200 ohms of it measured off. This is divided off into 10 equal lengths. If the wire is uniform, each of these will be 20 ohms. The 10 wires are soldered up in parallel, so that their resistance is 2 ohms. If there are any slight errors due to the unevenness of the wire the error will be small with the 10 coils in parallel, but, if the time can be spared, it is best to measure the 10 pieces, and cut them off at 20 ohms each. The voltmeter is put in

shunt to the resistance of 2 ohms thus made up, and the ammeter is put in series with them. The error caused by the current through the voltmeter going through the ammeter is too small to be considered. A dynamo is then switched on and readings are taken. As the electromotive force and current from a dynamo cannot be varied much, the electromotive force on the arrangement may be reduced by inserting resistances in series at random. If at all the readings the electromotive force as read on the voltmeter is twice the current as read on the ammeter it may be safely concluded that the instruments are correct. If the readings do not agree properly, and the resistances are measured carefully, either the voltmeter or ammeter is wrong or both are out. If the wires, which make up the resistances, heat, so that their temperature rises, this may cause a small error, but this can be avoided by letting the whole cool before taking each reading, or by taking a piece of the same size of wire and measuring its resistance cold, and after the current has been passing for some time and then allowing for the error. Of course, if the readings agree the instruments may be wrong, as one may read too high, and the other too low throughout, but this is very unlikely. A dynamo does not give as steady a current as secondary cells, but if the commutator is in good order, and if the brushes are set so that there is no sparking, there will be no perceptible error due to unsteadiness, especially if the commutator has many sections, and if the brushes have little lead.

If a voltmeter is to be checked, all that is wanted, besides a bridge and a galvanometer, is a few ounces of fine wire, and a standard cell, which costs thirty shillings.

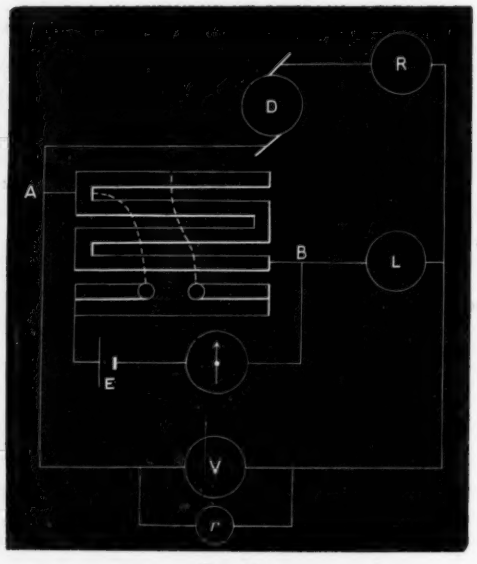


FIG. 27.

The arrangement is shown in fig. 27. The dynamo, D, takes the place of the little cells. The resistance, R, is about 10 times that of the voltmeter; and is adjustable, that is to say, it can be short-circuited out bit by bit so as to reduce the electromotive force on the voltmeter as desired. In most cases, however, it will be found impracticable to make an adjustable resistance 10 times that of the voltmeter, and the electromotive force can then be partly regulated by putting some resistance in series with the voltmeter and some in shunt as shown at *r*. The simplest form of adjustable resistance is a bare wire coiled in spirals, and provided with a clip for short-circuiting out as desired; L is a coil of fine wire of, say, 10,000 ohms. All that is necessary is to order, say, 1 ounce of No. 36 B.W.G., or 2 ounces of 35 B.W.G. German silver wire from the makers wound on a bobbin with both ends accessible. Before use the coil should be left for some weeks on the top of a boiler, or it may be boiled in paraffin. The resistance is then measured. The resistance part of the bridge is put in series with the coil, and the standard cell and galvanometer are in shunt to the plug resistance. The left hand key makes contact direct, and the right hand puts 1,100 ohms in series with the galvanometer to protect the cell from excessive current. If the electromotive force on the voltmeter is 100 volts, and if L is about 10,000 ohms there will be about 150 ohms drawn in the resistance box to balance the electromotive force of the standard cell. As this resistance can be altered ohm by ohm the upper part of the scale can be calibrated within ·6 per cent. Even this can be subdivided by noticing how much the galvanometer needle deflects each way. Thus, if with 120 ohms drawn, the galvanometer needle deflects 12° one way, and if with 121 ohms it deflects 4° the other, it would balance at 125·75 ohms. Of course, this is not good for the cell. It is best to have an ohm of wire stretched between L and the bridge, B being a sliding contact.

It is better to put the resistance box in shunt to the standard cell as shown, than to put the whole electromotive force of the dynamo on it, as that may be apt to injure the bridge. The arrangement is not direct reading of course, but if only one or two instruments are to be calibrated that is of no consequence. The electromotive force on the voltmeter is, of course, between B and A. $\frac{1{\cdot}435 \times L + t}{t}$, t being the resistance.

If the detector is fairly good and has a resistance of 250 ohms or so and a free needle, it will be found that this apparently rough method of calibrating is quite accurate enough for checking instruments within 1 per cent. or so. Care must be taken not to let the coil, L, get hot. Care must also be taken not to couple the standard cell backwards, and not to put the left hand key down till the resistance is adjusted as nearly as possible with the right hand key. If the cell is coupled up backwards it will be found out at once by its always deflecting the galvanometer the same way whatever the resistance drawn. At first, if there is any uncertainty the right hand key should only be touched down for a moment at a time. If the galvanometer does not prove to be sensitive enough, it is probably because there is some friction at the pivots. If it can be got, an instrument with a suspended needle is of course better.

It is more difficult to check an ammeter roughly, as a set of resistances must be made up. It will be best to consider the calibration of ammeters before discussing rough methods of gauging them in the workshop.

Ammeters are generally calibrated with a standard cell or by electro-deposition. If a standard cell is used the current through the ammeter is passed through a low resistance which is accurately measured, and the fall of electromotive force is measured, so that the current is known. As in the case of the calibration of voltmeters the ways of arranging the apparatus are very numerous. The chief difficulty lies in making a low resistance which can be accurately measured and which does not alter too much in resistance through heating. The resistance can be made up of a large number of coils of German silver or platinoid wire, preferably of platinoid, because if the wire has a certain surface per ohm, it will rise to the same temperature whatever the specific resistance of the metal, and for a given rise of temperature platinoid, as it is called, gives the lowest temperature error. A small wire that will carry 1 ampère without rising perceptibly in resistance is chosen. The resistance may be so arranged that it remains constant, and the current through it is varied so that the fall of potential varies. The fall of potential is then measured each time, or the resistance may be varied so that the current in each wire is always the same, so that the fall of potential is the same. This is the best method. Suppose the ammeters run from 1 up to 1,000 ampères, a number of groups of pieces of wire are arranged. One group consists of one wire

only of a resistance of, say 2 ohms. The next has two wires of 2 ohms each in parallel so that with 2 volts 2 ampères pass and so on, the groups consisting of 1, 2, 2, 5 ; 10, 20, 20, 50 wires and so on. In the case of groups of 20 or more wires, it is not necessary to measure each wire separately ; if the wire is fairly well made, a piece measuring 400 ohms can be carefully measured off and divided up into 20 equal lengths. Neighbouring coils should be wound in opposite directions, so as to neutralise each others' effects on any instruments near, as recommended by Prof. Fleming. The coils for 1,000 ampères thus form a set of 12 groups of coils, which, if 2 volts are kept on them, will give currents varying from 1 to 1,000 ampères by steps of only 1 ampère at a time. A larger wire capable of carrying, say 10 ampères, may be used for the third set, as it would be expensive to make up 1,100 spirals of small wire. The wires of each group, especially in the case of the large groups, are connected by thick copper bars of no perceptible resistance. These are all connected together at one end, at the other mercury cups are arranged so that the groups can be put into or out of circuit as desired. The mercury connections may be made by copper loops, but copper is apt to become amalgamated. Iron may have enough resistance to produce a perceptible fall of potential, so it is best to use copper well nickeled, as nickel protects the copper from mercury.

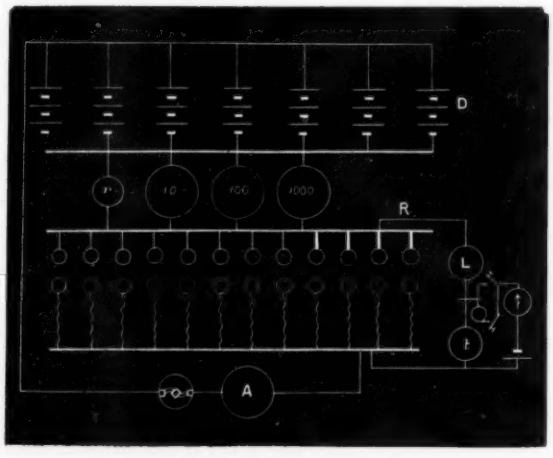


FIG. 28.

Figure 28 is a diagram of the arrangement. D is a set of secondary cells capable of giving 1,000 ampères and, say, 6 volts. The fall of electromotive force over bad contacts in switches, &c., is astonishing, and though only two volts are needed on the resistances, it is as well to have six or so at command.

The cells discharge through a set of regulating coils. These may consist of eight or twelve sets of coils on the same principle as the standard resistance, but not measured, and made without care as to rise of temperature beyond avoiding excessive heating. Instead of mercury cups, plugs or switches are used. Though this arrangement is simple, it cannot be worked very rapidly. What may be called conductivity switches are shown in fig. 29. The first puts in a maximum resistance of 1 ohm. It has ten contacts, so that at the last it only has $\frac{1}{10}$th ohm in, so that the conductivity is 10. It never short-circuits altogether, of course. On the next contact there is $\frac{1}{9}$th ohm in, and so on, so that it varies the conductivity from 1 to 10 mhos. The next is from 10 to 100 mhos, and the third is from 100 to 1,000 mhos. There is a rheostat, r, which is of, say, 2 ohms, with range down to half an ohm. The current can thus be varied from 1 to 1,000 ampères perfectly gradually. The conductivity switches are on the same principle as the crossbar switches described for putting resistance in series with voltmeters when calibrating them. The contacts should be very good, the cross-bars being made of stencil copper bent down so as to make good contact and

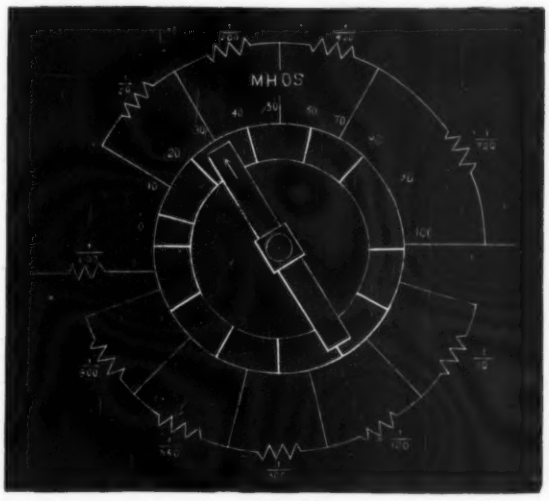


FIG. 29.

allow the switch to be turned either way. Conductivity arrangements are generally made to put varying numbers of coils in parallel. In this case the coils are in series, but the same effect is obtained with much quicker manipulation.

(*To be continued.*)

EVOLUTION OF THE ELECTRIC TELEGRAPH.

IT is impossible that the men who have just risen from the celebration of "The Jubilee of the Telegraph" can be misled by the nature of the function in which they have participated into the belief that the electric telegraph was invented only fifty years ago. They, or most of them, have too lovingly studied the story of man's acquaintance with the electric force, have absorbed too completely the literature which relates that story, ever to fall into so grievous an error. They have read Highton, Lardner and Bright, and Sabine, and lastly, we hope, Fahie, the latest and most complete historian of the electric telegraph ; and they know that for fully fifty years before Wheatstone and Cooke's successful experiment at Euston, quite a host of clever men had been concerning themselves in one way and another with the problem of how to electrically transmit intelligible signals to distant points. They need, therefore, no reminder from us that years before Her Gracious Majesty Queen Victoria ascended the throne of the United Kingdom, Ronalds, Ritchie and Wedgwood in this country, Schilling in Russia, Henry in America, and Gauss and Weber in Germany (to mention only a very few of the illustrious names associated with the development of telegraphy) enunciated, and in many cases demonstrated, the principles which govern this application of electricity. But they will doubtless agree with us that the present is a convenient time to recall and pass in review the various proposals and practical illustrations which preceded the commercial adoption of the electric telegraph, and to compare the crude methods suggested and shown by the earlier inventors with the elaborate and almost perfect apparatus which are the result of fifty years' careful and persistent consideration of requirement and possibility. By thus going over the past we shall more fully realise the great advances which the glorious reign of the present sovereign has witnessed, and the more readily re-echo the words of an early writer upon the telegraph, who commenced

his book with the exclamation, "What an age of wonder is this!"

When amazement at the wonderful powers of the great natural force which has within a century been subjugated to the will of man has, by reason of growing familiarity, somewhat abated, the first fact to strike us with surprise is that so many years were allowed to pass after the discovery was made that a current of electricity, when sent through a wire, could produce physical effects at a distance, before the knowledge thus gained was utilised in the transmission of signals and messages. In 1729 Stephen Gray discovered the principles of electric conduction and insulation, sending a current over pack-thread lines suspended at various points by loops of silk, to distances of 200 or 300 yards. This experiment was extended by Dufay in France, and by Desaguliers in England, and in 1742 Gordon, a Scotch Benedictine monk, who was Professor of Natural Philosophy at Erfurt, killed birds by means of the current from a glass-cylinder electrical machine at the end of an iron wire 250 yards long. In 1746, just after the invention of the Leyden jar, the shock obtainable from that jar was transmitted to a distance by Daniel Gralath, whose "line" consisted of 20 persons with outstretched arms. The Abbé Nollet in the same year sent a shock through 180 soldiers in Paris, and soon after, through a circle 5,400 feet in circumference formed of the monks of the Carthusian Convent holding iron wires in their hands. This last experiment established the practical instantaneity of the transmission, for all the monks in the circuit gave a sudden spring at the moment of the discharge from the Leyden jar.

Consequent upon these performances and those of Lemonnier, also of Paris (who employed circuits of 12,780 feet), Dr. Watson, who afterwards became Sir William Watson, was induced to engage in a series of experiments which resulted in what, regarded in the light of present knowledge, seems to have been a notable advance towards the telegraph of to-day. The suggestiveness of the effects obtained, however, do not appear to have presented itself to anyone who witnessed or took part in the experiments. In July, 1747, a wire was carried from one side of the Thames to the other over old Westminster Bridge, one end being connected with the interior of a charged Leyden jar, whilst the other was held by a person standing on the opposite bank; this person held in his other hand an iron rod which he dipped into the water. On the side where the jar was standing, and near it, stood a second person, who held in one hand a wire connected with the outer coating of the jar and in the other a rod of iron. When this rod was dipped into the river the circuit was completed, and both persons felt the accompanying shock. A month later the practicability of transmitting the shock through a circuit consisting of two miles of wire and two miles of perfectly dry ground was demonstrated. Benjamin Franklin in 1748 performed feats across the Schuylkill River at Philadelphia, similar to those of Watson across the Thames; and De Luc a few months later transmitted a current across Lake Geneva, but in none of these instances did the idea suggest itself that this power might be applied to a useful purpose. This is strange, for in all from the time of Gray were present the essentials of a perfect telegraph. There were the insulated line, the source of electricity, the transmission of current and obvious effects at a distance from the source. That the observation of these effects did not lead to the almost immediate application of electricity to purposes of communication between persons stationed at distant points seems to us now, nearly a century and a half later, most remarkable, but it only affords another illustration of how near a man may be to making a great discovery and then miss it after all. A principle which was afterwards employed for the interpretation of telegraphic signals by more than one inventor was introduced soon after the discovery of the Leyden jar by the Abbé Nollet, who suspended two threads in order that the presence and power of electricity might be indicated by their mutual repulsion. Leaden pellets and then pith balls were afterwards attached to the ends of the threads, and in this form the device was used in telegraphy by Ronalds, Lesage, Lomond, and others, certain motions of the pith balls representing certain letters of the alphabet.

But nearly a quarter of a century elapsed after Gray's discovery that electricity might be conveyed along wires before the first suggestion was made of an electric telegraph, and even then, so far as is known, it was only a suggestion. In February, 1753, six years after the investigations of Sir Wm. Watson, a letter signed "C. M.," appeared in the *Scot's Magazine*, published at Edinburgh, in which a proposal was made that a set of wires equal in number to the letters of the alaphabet, should be extended between two given places and electrical impulses transmitted over them for the purpose of carrying on a conversation. This letter of "C. M.," who is the Junius of telegraphy, inasmuch as his identity is still shrouded in mystery, was quite recently published in the ELECTRICAL REVIEW (Vol. XIX., p. 442), so that there is no necessity for reproducing it here. It is sufficient to say that his idea was by electrifying a ball to attract pieces of paper containing letters placed beneath it, the letters attracted spelling the words of the sentence to be communicated. He included, though unconsciously, the use of the earth for the return portion of the circuit in his system, and in this he was followed by several other inventors who were equally unaware of the fact.

According to Fahie, Joseph Bozolus, a Jesuit and lecturer on natural philosophy in the College at Rome, was the next to suggest an electric telegraph. This must have been anterior to 1767, for in a poem published in that year Mazzolari alluded familiarly to the proposition, which was that two wires should be laid underground between two stations any distance apart, the ends of the wires at each station being brought near to each other when it was desired to converse so that a spark might pass between them. A spark alphabet, Bozolus said, could be devised, and a means of communication be thus contrived.

Louis Odier, of Geneva, in 1773, wrote vaguely of certain experiments he proposed to make whereby he would be enabled "to enter into conversation with the Emperor of Mogol, or of China, the English, the French, or any other people of Europe." Odier had just met Franklin, Priestley, and others, and conceived his idea from something which he heard casually at table with them, but he does not appear to have attempted the task he proposed to himself.

An anonymous correspondent of the *Journal de Paris* in May, 1782, described as a "scientific amusement" a method of establishing communication between two very distant places by putting two gilt iron wires underground in separate wooden tubes filled in with resin, each wire terminating in a knob. Between one pair of knobs a letter formed of metallic strips was to be suspended, and this was to be illuminated by discharging a Leyden jar through the wires. With twenty-four pairs of wires any desired word could be quickly spelled. These means could be simplified, the writer pointed out, by having only five pairs of wires, and attaching a character or letter to each of their combinations.

Now we come to the period at which speculation was abandoned and practical experiment was entered upon. To Lesage, a Frenchman residing at Geneva, belongs the honour of having established the first telegraph wire for the transmission of intelligible signals. His system was almost the realisation of the idea of the Scotchman, "C. M." He erected at Geneva, in 1774, a telegraph line of twenty-four metallic wires, insulated from each other. Each wire was connected at the further end to a separate pith-ball electroscope and corresponded with one of the letters of the alphabet. Upon an electric current being sent over any one of these wires the pith ball attached to the wire diverged from it and the letter to be sent was thus denoted. It may be noted that while Highton and Sabine (both of whom derived their information from the Abbé Moigno) give the date of Lesage's line as 1774, Fahie

does not credit him with having achieved the invention before 1782. In a letter written in the latter year, Lesage says the idea occurred to him thirty or thirty-five years before. He there describes a method still more closely resembling that of "C. M.," for instead of the signals being composed by the divergence of pith balls, they were indicated by the agitation of pieces of gold leaf under the influence of the current, these pieces of gold leaf thus taking the place of "C. M's" pieces of paper.

A great advance was made by the inventor next in order of date, Lomond, of Paris, who in 1787 constructed a telegraph with only one wire. An electrical machine was placed at one end of the line and a pith-ball electroscope at the other. Two balls were employed, and the different signals were given by the number and variations of their divergences. Claude Chappé entertained the idea of telegraphing by means of the discharge of a Leyden jar in 1790, employing a synchronous clockwork dial for the interpretation of the signals; but a difficulty occurred in regard to the insulation of his lines, and he abandoned electricity and resorted to optico-mechanics, his investigations in this direction resulting in the invention of the semaphore.

The next system of importance was that of Reusser, who in 1794 used twenty-six wires and showed the letters of the alphabet marked on squares of tinfoil and rendered luminous by sparks of electricity. There is a curious difference of opinion with regard to this system between Highton and Sabine on the one hand, and Fahie on the other. The two former say that Reusser (Highton calls him Reizen) pasted parallel strips of tinfoil upon squares of glass, cutting away portions of the metal so that the blank spaces formed letters in the manner shown in the cut.

Wires being attached to the + end of the tinfoil strips, the effect of sending a current through would be that sparks would pass over all the breaks at the same time, the spaces would be illuminated and the letters would stand out in lines of light. Fahie disputes the accuracy of this description, asserts that Don Salva first described this luminous letter method, and quotes the description of Reusser himself to show that the latter intended something different, though wherein the supposed difference consists he does not clearly state. Reusser says:—"On an ordinary table is fixed, in an upright position, a square board to which a glass plate is fastened. On this plate are glued little squares of tinfoil, *cut after the fashion of luminous panes*, and each standing for a letter of the alphabet. From one side of these little squares extend long wires, enclosed in glass tubes, which go underground to the place whither the dispatch is to be transmitted. The distant ends are there connected to tinfoil *strips* similar in all respects to the first, and, like them, each marked by a letter of the alphabet; the free ends of all the strips are connected to one return wire, which goes to the transmitting table. If now one touches the outer coating of a Leyden jar with the return wire, and connects the inner coating with the free end of that piece of tinfoil which corresponds to the letter required to be indicated, sparks will be produced, as well at the near as at the distant tinfoil, and the correspondent there watching will write down the letter." This seems to be as clear a description of the broken strip indication of the letter which Highton and Sabine attribute to Reusser as could be desired, and we are at a loss to comprehend Fahie's grounds for differing from the older historians.

Spark methods of telegraphing were also proposed by Böckmann, Lullin, and Cavallo, all of whom employed but one or two wires, about the years 1794-5; these systems varied only in the combinations of sparks and intervals used as a code. Don Francisco Salva has been before mentioned. He employed illuminated letters similar to those of Reusser, but in course of time he reduced the number of wires to one. His experiments in 1796 attracted the attention of the King of Spain and the Infante Don Antonio. The latter evinced considerable interest in the telegraphic project, and for a time appears to have joined Salva in his investigations. Whether his interest continued after the novelty of the idea had passed off we are unable to discover, but Salva persevered to such purpose that two years later, in 1798, a line 26 miles in length was erected between Madrid and Aranjuez. This line, which consisted of a single wire, has usually been attributed to Betancourt, but it is pretty certain that Salva was its author.

Hitherto we have been dealing entirely with systems in which static or frictional electricity was used. A landmark in the development of the telegraph was established by the introduction of the voltaic pile about the year 1800. Many minds were at once turned to the employment of the new source of electricity for telegraphic purposes, and, while the older forms of producing a current were not entirely abandoned until many years later, most of the devices which followed utilised the voltaic or galvanic battery. Salva was the first to use the pile in conjunction with the telegraph, but it is curious to note that in the early part of 1800, before he had heard of Volta's discovery, he was already experimenting with electricity obtained from a number of frogs, this method, of course, being suggested to him by the discoveries of Galvani. On February 22nd, 1804, he read a paper before the Academy of Sciences at Barcelona entitled "The Second Treatise on Galvanism applied to Telegraphy," and in the experiments illustrating this paper, "Volta's column" was for the first time used in connection with a line wire for the transmission of electric signals. As to the means of indicating those signals at the distant point, Salva showed some hesitation. He alluded to the contractions of frogs as adequate to the effect, but manifested an inclination to employ the decomposition of water. For this last means he pointed out that, the ends of each pair of wires being inserted through a cork into a glass tube containing water, when a current was sent through the water the end of the wire communicating with the zinc plate of the pile was covered with bubbles of hydrogen and the other with oxygen. As these effects could be reversed by the reversal of the current, each pair of wires was capable of representing two sets of signals. Six wires, he thought, would be enough for a telegraph. From these facts it is clear that to Salva, and not to Sömmering, who for so many years enjoyed the credit, belongs the honour of first applying voltaic electricity to telegraphy.

Sömmering's telegraph was based on the same principle as Salva's, and was not very dissimilar in detail, but it was some years later, the wars between France and Austria in 1809 giving rise to the invention. Chappé's semaphores proving of great value to the Emperor Napoleon, the Bavarian Minister, Montgelas, requested his friend Dr. Sömmering to bring the subject of telegraphs before the Academy of Sciences at Munich. Sömmering at once gave the problem his attention, and soon it occurred to him to try whether the visible evolution of gases from the decomposition of water by the voltaic current might not answer the purpose. He worked at this idea incessantly, and before three days had elapsed had constructed his first apparatus. He took five wires of silver or copper, and, insulating each with a thick coating of sealing wax, bound the whole up into a cable. These wires at one end terminated in five pins which penetrated a glass vessel containing acidulated water; and at the other were capable of being put in connection with the poles of a pile of fifteen pairs of zinc discs and Brabant thalers separated by felt soaked in hydrochloric acid. By touching any two of the wires to the poles of the

pile he was able to produce at their distant ends a disengagement of gases, and thereby indicate any one of five letters. Having found that this operated successfully, he extended his apparatus, and on August 29th, 1809, exhibited to the Munich Academy of Sciences a telegraph consisting of thirty-five insulated copper wires terminating at one end in an equal number of gold points, and at the other attached to thirty-five brass terminals; each wire corresponded with one of the twenty-five letters of the German alphabet or with a numeral. A year later the inventor added to his apparatus a contrivance for attracting attention at the distant station. He made the gas rising in small bubbles from two contiguous pins in the water collect under a sort of inverted glass spoon at the end of a long lever, which, rising, made a second lever bent in the opposite direction on the same axle descend and throw off a little perforated leaden ball, resting lightly on it, and which, falling on an escapement, set the clockwork of an ordinary alarum in motion. This telegraph, though complex and unpractical, attracted a great deal of attention, princes, statesmen, and philosophers thronging to the inventor's lodgings to witness its performances. At the suggestion of Schilling, Sömmering in 1811 made experiments which demonstrated that, instead of a return wire, water or the earth, might be drawn into service for the completion of the circuit.

Schweigger, of Nüremberg, in preparing an account of Sömmering's telegraph for insertion in his *Journal für Chemie und Physik*, suggested a variation which would only require two wires. His proposition was that two piles should be used, one considerably more powerful than the other, so that at one time the weaker one and at another the stronger might be used, and even both together. By this arrangement the amount of gas produced in a given period at the distant station would be varied, a small quantity denoting one letter and a larger another. Schweigger also proposed methods of permanently registering the letters denoted by means of paper smeared with lampblack and other substances.

Mr. J. R. Sharpe, of Doe Hill, near Alfreton, who had been a London solicitor, claimed in 1816 to have completed a telegraph employing "the certain and rapid motion of the electric principle through an extensive voltaic circuit" three years earlier, and before he had heard of Sömmering's telegraph, but he gave no particulars of his system, and none have since been ascertained. His telegraph was exhibited before the Lords of the Admiralty, who, though approving the design, dismissed it with the remark that "as the war was over, and money scarce, they could not carry it into effect."

Here we may recur once more to the telegraphs based on static electricity, and to the earlier years of the century. The discovery of important documents in the Imperial archives at Paris by M. Gerspach, twenty-five years ago, has left little room for questioning the authenticity of Jean Alexandre's telegraph of 1802. Alexandre had an eventful career, characteristic of the times and the country in which he lived. In 1787 he was following the trade of a gilder at Poitiers and singing in the church choirs; when the revolution reached Poitiers he went to Paris and maintained himself by singing in the choir of St. Sulspice. When this church was closed he drifted into politics, and after a time became Commissary-General of War, receiving further exaltation at a subsequent period, when the title of Chief Agent of the Army of the West was conferred upon him. Yearning for a quiet life, he quitted honours and politics, and returned to his home at Poitiers, as poor as he had left it. In 1802, he wrote to the Minister of the Interior, informing him that he had devised a *télégraphe intime*, and asking for assistance to enable him to go to Paris and exhibit his machine to the Government. He refused, however, to tell the secret of his apparatus to any but the "First Consul," Napoleon Buonaparte. A most interesting report upon Alexandre's telegraph was drawn up by the celebrated astronomer, Delambre, at the request of the First Consul, the concluding words of which were as follows: "He [the inventor] makes a secret of his discovery, and I ought to judge it with severity and according to the laws of probability; but the limits of the probable are not those of the possible, and Citizen Alexandre must be sure of his facts, since he offers to expose all to the First Consul. It, therefore, only remains for me to hope that the First Consul will grant him an audience, and that, in the sequel, he will have reason to welcome the inventor and recompense worthily the author." Alexandre never had the audience, it is to be presumed, for nothing further was heard of his secret telegraph. Four years later he took out a patent at Bordeaux for filtering the water of the Garonne, and in 1831 he submitted to King Louis Philippe a project for steering balloons. His death occurred soon after, and his widow died in 1833 at Poitiers in extreme want. His secret perished with him; but Fahie believes that he had in effect constructed a telegraph of the step-by-step, or A, B, C sort, based upon the contrivances of Lomond and Chappé.

Ralph Wedgwood, a relative of the famous Josiah, abandoning the business of a potter which he had carried on at Burslem, came to London in 1806, and devoted himself to invention, and to the electric telegraph in particular. In 1814, having perfected his plans, he submitted them to Lord Castlereagh at the Admiralty, but was dismissed with the stereotyped reply that "the war being at an end, and money scarce, the old system [of shutter semaphores] was sufficient for the country." Wedgwood dropped the project in disgust, and unfortunately left no account of its construction or mode of action.

(*To be continued.*)

Electric Railway in the Wild West.—The "Wooing Witch of the Wild West"—*the* Wild West, not Mr. William Buffalo's imitation of it—in other words, Wichita, in Kansas, is to have four miles of electric railway in operation by August 1st. The system is a series circuit one, and the invention of Mr. W. L. Selden, of St. Louis, who is superintending the construction for the Advance Electric Company. Electricity has evidently beguiled the Witch, for she has a 120-light Thomson-Houston plant, 2,000 Fort Wayne Jenney incandescent lamps, and 200 Schuyler arcs in full swing.

Compressed Air for Electric Lighting.—To avoid the difficulties and the inconvenience attending the use of steam engines, a strong company has been formed in Paris, *Industries* states, for the supply of compressed air to users of dynamo machines for electric lighting. A central station has been provided where engines of 3,000 aggregate horse-power will compress the air for this purpose. The mains are already being laid, and the work is being pushed on with all possible speed to furnish motive power to the theatres within the time allowed by the Government order for the substitution of electric light for gas. With electric lamps and compressed air engines the maximum of safety from fire will be attained. The offices of the *Figaro* are to be the first to be lighted by this means. The scheme is to be extended to the provinces, and Lille will probably be the first town to adopt it.

The Telephone in China.—It is said that a syndicate of capitalists have secured the right to introduce the telephone into China. They don't know what trouble they are bringing on themselves, says an American exchange. In the Chinese language delicate shades of meaning are given to the same word by a very slight inflection of the voice, and it is doubtful if the telephone will register or convey these inflections. If, for instance, a Chinese merchant wanted to have a lunch sent to his place of business, and gave the appropriate order, "Wang-wang" through the telephone, it would very seriously disturb his equanimity if the telephone people thought he ordered a large and ferocious bull pup.

THE JUBILEE OF THE TELEGRAPH.

COMMEMORATIVE DINNER.

THE dinner to commemorate the fiftieth anniversary of the successful establishment of Cooke and Wheatstone's telegraph line between Euston Station and Camden Town, took place in the Venetian Hall at the Holborn Restaurant on Wednesday evening. The Right Hon. Henry Cecil Raikes, M.P., the Postmaster-General, presided, and the company present numbered 250. The proceedings were characterised by the utmost enthusiasm, repeated outbursts of hearty applause greeting the names of well-known pioneers of telegraphy, both by land and sea. To every speaker was extended a cordial reception, but the loudest and most prolonged cheering was that which broke forth when Sir William Thomson rose to speak. Sir William was anxious that early inventors should not be forgotten in the congratulations deservedly poured upon those who remain alive to witness the outcome of their faith and enterprise, and he recalled the names of Oersted, Ampère, Gauss and Weber, Steinheil and others, as those of men well deserving to be honoured by the telegraph engineers of the present day.

A large number of letters and telegrams of regret and congratulation were received during the day, among others from the Marquis of Salisbury, Lord John Manners, Lord Cross, Sir Henry Holland, Mr. W. H. Smith, Sir W. B. Grove, Sir Daniel Gooch, Sir Julian Goldsmid, Sir A. Borthwick, M. Mascart, M. Coulon, M. Fribourg (of Paris), Mr. Delarge (Belgium), Mr. Koller and Mr. Hopstedi, of the Hague, Dr. Von Stephan and Dr. Siemens (Berlin), Mr. Cracknell (Sidney), Mr. C. Todd (Adelaide), British electricians in the United States, Sir Albert Cappel, Gen. Eckert (America), and from telegraph men in Tasmania, New Zealand, Western Australia, Lima, and Queensland.

After the announcement of the presence of Mr. Jacob Brett, perhaps the most interesting communication made during the evening, was that by Mr. Latimer Clark when he stated his intention of handing his unique collection of original documents relating to various phases of telegraph development over to the Society of Telegraph-Engineers and Electricians. The society will be considerably enriched by this addition to its historiographical treasures, and Mr. Clark, who has already done much for the society, will still further earn the gratitude of the members. Lack of time and space preclude any further comment. The arrangements were good, the officials energetic, and the dinner excellent; a capital selection of music was given under the direction of the Electro-Harmonic Society, with Mr. T. E. Gatehouse and Mr. Arthur Thompson as musical directors, Mr. W. G. Forrington, Mr. Battison Haynes, Madame Florence Winn and Miss Ethel Winn being the artistes who contributed to the musical pleasures of the evening.

Amongst the company present were :—

Sir Jas. Anderson, Prof. W. G. Adams, F.R.S., Sir Fredk. Abel, C.B., F.R.S., Col. R. A. Andrews, Mr. J. Ardron, Mr. W. Andrews, Mr. G. L. Addenbrooke, Mr. J. Appleton, Mr. H. Alabaster, Mr. B. Bruce, Mr. F. E. Baines, C.B., Mr. C. H. W. Biggs, Mr. Andrew Bell, Mr. T. Benton, Mr. T. Buckney, Mr. A. Brown, Mr. R. T. Brown, Mr. A. S. Bolton, Mr. E. L. Berry, Mr. S. H. Byrne, Mr. Jacob Brett, Mr. J. C. Bright, Mr. H. Borns, Mr. A. S. Betts, Mr. W. C. Benedict, Major C. Beresford, R.E., Mr. G. L. Bristow, Mr. John Bass, Sir Charles T. Bright, Mr. T. A. Bulloch, Mr. H. Benest, Mr. E. B. Bright, Mr. Ino. Bordeaux, Mr. W. Crookes, Mr. Edwin Clark, Mr. Latimer Clark, Mr. C. F. Cartwright, Mr. W. R. Culley, Mr. S. W. Chetwynd, Mr. C. Curtoys, Mr. W. A. Cowper, Mr. T. W. Casserley, Mr. T. R. Crampton, Mr. W. L. Carpenter, Mr. M. Cooper, Mr. H. Crookes, Mr. G. von Chauvin, Mr. F. W. Cooke, Mr. A. F. Clement, Mr. H. Clifford, Mr. J. T. Crowe, Mr. R. Collett, Mr. R. C. Day, Mr. J. F. Ducloy, Mr. F. Despointes, Mr. B. Drake, Mr. H. C. Donovan, Mr. W. H. Davies, Mr. D. Davies, Mr. D. J. Dunlop Mr. E. Dickens, Mr. F. J. Down, Mr. George Draper, Mr. A. Dearlove, Mr. H. Eaton, Mr. H. G. Erichsen, Mr. F. E. Evans, Mr. H. Edmunds, Mr. J. R. Edwards, Sir George Elliott, Mr. W. B. Esson, Mr. H. Erichsen, Mr. M'Cail, Prof. G. Forbes, Dr. J. A. Fleming, Mr. H. C. Fischer, Mr. Thos. Fletcher, Mr. C. T. Fleetwood, Mr. J. R. France, Mr. J. W. Fletcher, Mr. Wm. Ford, Dr. J. H. Gladstone, F.R.S., Mr. Ed. Graves, Sir Fredk. Goldsmid, Sir D. Galton, F.R.S., Mr. Matthew Gray, Mr. Robert K. Gray, Mr. J. H. Greener, Mr. W. T. Glover, Mr. M. H. Gray, Mr. A. E. Gilbert, Mr. E. Gilbert, Mons. Gody, Mr. H. T. Goodenough, Mr. A. Graves, Mr. C. Gerhardi, Mr. T. E. Gatehouse, Mr. J. Hookey, Mr. R. Hunter, Mr. A. E. Horton, Prof. D. E. Hughes, F.R.S., Mr. A. Hoster, Mr. W. Hancock, Mr. R. S. Hampson, Mr. R. R. Harper, Mr. F. T. J. Haynes, Mr. W. W. Hibberdine, Mr. F. Higgins, Mr. F. E. Hesse, Captain R. C. Halpin, Mr. S. Incledon, Mr. H. Imray, Mr. R. W. Johnston, Col. R. Jackson, Mr. W. C. Johnson, Mr. R. J. Jenkins, Mr. J. T. Johnson, Mr. G. Kapp, Mr. J. Killick, Mr. H. R. Kempe, Mr. H. H. Kingsbury, Mr. F. W. A. Knight, Mr. J. E. Kingsbury, Mr. C. Kierzkowski-Steuart, Mr. Norman Lockyer, F.R.S., Mr. D. Lumsden, Mr. J. C. Lamb, Mr. E. March Webb, Mr. J. Laister, Mr. J. J. Latey, Jun., Mr. W. Lynd, Mr. L. Loeffler, Mr. C. W. Lundy, Mr. J. S. Lewis, Mr. H. F. W. Lewis, Mr. W. Leonard, Mr. J. S. Macdonald, Mr. H. Musgrove, Mr. E. May, Mr. W. M. Mordey, Mr. A. Muirhead, Mr. C. Manceau, Capt. C. McEvoy, Mr. J. May, Mr. J. Miles, Mr. J. McLean, Mr. H. Marsh, Hon. H. Marsham, Mr. O. Moll, Mr. S. Morse, Sir H. Mance, C.I.E., Mr. F. C. C. Nielson, Mr. J. Neale, Mr. G. R. Nielson, Mr. G. G. Newman, Mr. J. Oldham, Lord Onslow, Mr. A. M. Ogilvie, Mr. John Pender, Mr. C. H. B. Patey, C.B., The Postmaster-General, Sir C. Lyon Playfair, M.P., F.R.S., Mr. A. Pamphilon, Mr. S. E. Phillips, Mr. W. H. Preece, F.R.S., Mr. A. H. Preece, Mr. W. L. Preece, Mr. J. Probert, Mr. E. Penton, Jun., Mr. Bennett Pell, Mr. W. Payton, Mr. W. Roche, Mr. E. C. Rimington, Mr. F. L. Rawson, Prof. A. W. Rucker, F.R.S., Mr. J. R. Radcliffe, Mr. J. Reid, Count Reichenbach, Mr. F. Rudall, Mr. S. W. Silver, G. Shaw Lefevre, M.P.; Prof. G. G. Stokes, F.R.S.; Sir D. Salomons, Mr. G. Sutton, Mr. W. H. Snell, Mr. A. Stroh, Mr. A. Siemens, Mr. H. Swan, Mr. A. T. Snell, Mr. J. W. Swan, Mr. J. S. Sellon, Mr. A. A. C. Swintcn, Mr. J. Scott, Mr. A. S. Schanschieff, Mr. J. N. Shorter, Mr. Julius Sax, Mr. C. W. Stronge, C.B.; Mr. H. Sach, Mr. H. A. C. Saunders, Mons. H. Serrin, Mr. C. E. Spagnoletti, Mr. B. Smith, Mr. W. O. Smith, Mr. W. S. Smith, Mr. F. Smith, Mr. W. Shuter, Sir W. Thomson, F.R.S.; Mr. W. J. Tyler, Prof. S. P. Thompson, Mr. W. H. Tasker, Mr. J. Taylor, Mr. R. von F. Treuenfeld, Mr. W. T. Tunbridge, The Marquis of Tweeddale, Mr. H. A. Taylor, Mr. F. G. Underhay, Mr. F. H. Varley, Mr. H. Weaver, Mr. C. E. Winter, Mr. A. C. Woodward, Mr. J. W. Wilmot, Mr. F. H. Webb, Mr. H. D. Wilkenson, Mr. Trueman Wood, Mr. S. Walliker, Mr. T. E. Weatherall, Mr. J. Walsh, Mr. A. Whalley, Mr. P. Waterlow, Maj. Gen. C. E. Webber, C.B.; Mr. Lewis Wells, Mr. T. H. Wells, Mr. E. Yeld.

TELEGRAM FROM THE QUEEN.

The Postmaster-General, during the evening, despatched the following telegram to Sir Henry Ponsonby, at Osborne :—"A large dinner party, celebrating the Jubilee of the Electric Telegraph, remember with gratitude and pride that all the progress has taken place in the happy and prosperous reign of Her Majesty and under her fostering care."

To this the following reply was received :—"The Queen thanks you for your telegram. It gives Her Majesty much pleasure to reflect on the improvements which have been made in Wheatstone's great invention which was first practically tested in her reign."

THE CHAIRMAN, who was received with prolonged cheers, then said: Gentlemen, the first toast upon every public occasion of this kind during every year of the long reign among her faithful subjects has been the Health of Her Majesty the Queen —(cheers)—and I am happy to think that upon no occasion and in no year can that toast have been more appropriate than it is on the occasion which brings us here to-night to celebrate the jubilee of perhaps the greatest scientific discovery in its applied form that has ever yet come to improve the lot of man—(applause)—and it is a happy coincidence that the jubilee of the telegraph so closely coincides with that of the best of sovereigns. (Cheers.) During the 50 years which have elapsed since Her Majesty Queen Victoria ascended the throne of this realm we have come to associate her so closely with that triumphal march of progress and, on the whole, of peace which has distinguished that long period that we sometimes run almost some risk of ceasing to appreciate as we ought to do her own individual merits and virtues as a woman and as a sovereign—(applause)—but I feel that the events of this past year have brought so largely into view the personal aspect of English Royalty that it is with renewed energy, and if possible with redoubled loyalty that I beg you to drink "The Health of Her Majesty the Queen."

The toast was honoured with the greatest enthusiasm, the entire company afterwards joining in singing the National Anthem.

THE CHAIRMAN: Gentlemen, there is a somewhat graceless proverb that tells us that there is nothing sacred to an engineer. I venture to believe that that is a misrepresentation of a body of men who at least know how to reverence all that is deserving of respect—(applause)—and I wish before we proceed to any other of the toasts upon our list to ask you to join in an expression of reverence for those great and illustrious men, many of whom have ceased to be among us, but some of whom I hope still survive, and I ask you to drink in solemn silence, as a mark of respect and reverence, "To the Memory of the Pioneers of Telegraphy."

The CHAIRMAN then said: Gentlemen, it now falls to me to propose to you the toast of the evening, and I may, I think, well say that no one ever approached a task of great interest and great magnitude with a fuller sense of his own unworthiness to discharge it. I see before me the men who have done so much to extend and to popularise the progress of science, and I must ask you to be tolerant if, in the few observations which I shall venture to address to you, I show how little the labours and engagements of political life enable one to follow that great march of scientific progress whose Jubilee in a special walk we are celebrating here to-night, and I feel this perhaps all the more because I am conscious that among my predecessors in the office which I now hold there is at least one man present, whose name is a household word wherever science is known and venerated, and who would be more infinitely competent to discharge the duty which has fallen upon me. But as you will have the privilege of listening to Sir Lyon Playfair, when he proposes another toast, I will venture without further apology to commend to you to the best of my power the toast which forms the subject of our gathering here to-night. Gentlemen, you are all aware that last Monday was the fiftieth anniversary of the first occasion on which the electric telegraph was brought into operation in England—(applause)—and we have most of us perhaps read of that tumultous sensation which the great Wheatstone confesses to have experienced when the message which he sent on that little journey from Euston Square to Camden Town was sent back to him by Mr. Cooke. (Cheers.) I am perhaps not exaggerating the importance of that occasion when I venture to say that that evening as Wheatstone sat in the small cupboard of an office communicating with his colleague at a distance of some two miles, was one of the great epochs in the history of human progress—(loud cheers)—and if ever a spirit of prophecy has filled a man with something of a divine enthusiasm, it may well be that the man with whose name the system of the electric telegraph must ever be inseparably connected, may have felt his heart throb with something almost supernatural when he realised that the great work had been achieved, that the demonstration had been reached, and that the future of the science was assured. (Cheers.) If he could have looked forward to those circumstances which are to us part of our everyday lives, he may well have been excused for such a shock to the nerves as hardly any seer of old can ever have encountered in peering into the dark future. (Applause.) I venture to believe that when we look back upon the progress of those 50 years, we shall find in them the materials for a greater hope of the future of humanity than in almost any other record of any other period in the history of our race. I would remind you that the instrument which was employed by Wheatstone and Cooke displayed 5 needles and that it was from he movements and combinations of those 5 needles that the whole of the alphabet was made up. Those 5 needles, we are told, were united by means of 5 copper wires laid in a groove in a triangular block of wood, and I am sure you will be interested to know that a piece of that block is in my hand at the present time—(cheers)—and well deserves to be preserved among the archives of science. Well of course we are with the experience of this half-century well aware that this system in the first instance was crude and imperfect. Demonstration had been arrived at but perfection had to be reached. The difficulty that was immediately encountered in popularising the system was obviated by the development of the railway enterprise of this country and the necessity which arose for rapid and certain communication along our lines of railway. And those of us who are in the habit of travelling by the different great lines of the kingdom may I think for a moment indulge ourselves in the idea of what railway travelling would be if there was no electric telegraph. (Laughter and cheers). However, some time elapsed before the real development of telegraphy in this country began. The London and Blackwall railway was, I believe, the first to utilise the system in a practical way. In 1844 the government of Sir Robert Peel first conceived the idea of utilising the telegraph for other than railway purposes—at least they were the first to realise how far it might be applied to the service of the state—and that year saw the establishment of a telegraph line from Waterloo to Gosport of four wires, of which two were to be utilised by the railway company and two by the Government, and that I think you may say constituted the first public recognition of the value of the electric telegraph. (Applause.) In 1846 the first telegraph company was formed—the Electric Telegraph Company. (Cheers.) In 1850 the first attempt was made to lay a submarine telegraph cable. (Cheers.) A gutta-percha wire, without any metallic covering, was laid between Dover and Calais in August of that year, and you will be interested to know that I have also here a portion of that cable, which was fished up by a ship in the Channel so recently as the year 1875. I am told that the first concessionaire of that cable is present here this evening. (Cheers.) In 1851 a cable was laid in substitution of this gutta-percha cable, which was protected by iron wires, and which was the commencement of a regular system of inter-communication between England and the Continent, and this cable I believe I am not wrong in associating with the name of one of those gentlemen who is happily still spared to be among us, and to whom I referred just now in connection with the last toast,—I mean Mr. Crampton—(cheers)—and it must indeed be a great satisfaction to anyone who has been connected with great works of this sort to have lived, as Mr. Crampton has done, to witness their enormous development in the service of mankind. The first Atlantic cable was laid in 1858, and other companies arose during those years to compete with the first electric telegraph company, and multiplied throughout the length and breadth of England the agency of the telegraph. In 1870 the multiplication of the companies had become so great that their competition, though in some respects advantageous to the public, was yet so imperfectly regulated by State requirements, that the Government of the day determined to acquire the whole of their enterprises, and to place the telegraphs of the kingdom under the direction of the Post Office. (Cheers.) Now, I should like to say one or two words with regard to the instruments of telegraphy. We are aware—and anyone who wishes for ocular inspection may satisfy himself—that the first telegraphic apparatus employed by Wheatstone and Cooke was one which required five wires through which to transmit their message. It was found gradually that two wires would suffice to forward a message, and after that the progress of science enabled the operators to depend upon one. But after a time it became ascertained that a wire could be used for sending messages in two directions, and after that time four messages came to be transmitted on a single wire, two in either direction, and, as I dare say most gentlemen who are present to-night are aware, at the present time a single wire is being used at the central telegraph station in such a manner as to admit of six messages being sent in one direction, or one in one direction and five in the other, or any other combination of six messages—(cheers)—and I think that those who have perfected these wonderful operations may be thankful that they live in the reign of our present good Queen—(cheers)—because I am perfectly satisfied that if they had lived in the reign of good Queen Bess most of those gentlemen would have expiated their scientific offences by being burned at the stake. (Loud laughter.) The first five needle instrument was succeeded by the double needle, and the double needle by the single needle; all those systems were visual. Then came in the system of printing on a band of paper. At first the signs representing the letters were embossed on the band. This was further improved by Professor Hughes's printing instrument—(cheers)—by which the actual letters were printed in ink. Then came yet another, probably even more, astounding development—the sounder instrument, by which messages are transmitted by sound without any record. (Applause.) I venture to believe that that achievement has outstripped the wildest dreams of imagination. With regard to speed, that, I think, is also an interesting point. When the first electric telegraph was established the speed of transmission was from four to five words a minute on the five needle instruments. In 1849 the average rate of transmission of a certain number of messages addressed to the *Times* newspaper was 17 words a minute. The present pace of the electric telegraph between London and Dublin, where the Wheatstone automatic instrument is employed, amounts to 462 words a minute—(cheers)—and thus what was regarded as miraculous 50 years ago, has multiplied a hundredfold in the course of one half century. Now you may perhaps like to know, though it is rather descending from the higher walk of this great subject, the number of telegrams which were sent through the Post Office in the United Kingdom last year. The number was 51,500,000—(cheers)—that is nearly 1,000,000 per week, and that number is still steadily increasing. 41,000,000, or rather more than that number, of these were nland messages, and of course a very great proportion of them were Press messages. I think you should realise the immense boon which the electric telegraph has bestowed upon the Press. I gather from such information as I have been able to obtain that the rate of Press messages, which as everybody is aware is very much less than the rate for other messages, is on the average not much more than 2d. per 100 words; and it is owing to these extraordinary facilities, afforded by the Post Office to the transmission of Press news, that the whole of the United Kingdom is put in possession at its breakfast table every morning of everything which it is necessary or important for anybody to know, as well as of a great many things which are neither necessary nor important. (Laughter and cheers.) I believe that I am not wrong in saying that the cost to the public revenue of this reduced rate to the Press is not less than £200,000 a-year, and that the newspapers of this country practically receive a subsidy of £200,000 a year in order to enable them to assist in the diffusion of intelligence. (Applause.) I imagine that the country is well satisfied that this should be so, and that there are very few people who would wish to abridge that privilege, having regard to the enormous importance to all classes of the community of being placed at the earliest moment in possession of the fullest knowledge of what is going on. (Applause.) But it is a fact that, owing to the recent reduction in the tariff of telegrams, the value of the telegram on the average to the State is now only 8d., whereas two years ago it was 1s. 1d.; and before the State took over the telegraphs it amounted to as much as 2s. 2d. I think you may measure something of the enormous gain which the public has achieved by the acquisition by the State of the telegraph system when you look at these figures and reflect that the average price of a telegram at the present time is only about a third of what it was only 17 years ago. (Applause.) I am saying this as if I were one of the public; but as Postmaster-General you must be aware that I have to regard this result with somewhat mixed feelings—(laughter)—and I am endeavouring, as far as I can, to denude myself of any official prepossession in putting before you from the popular side the advantages which you have obtained by the State employment of the telegraphs. But, gentlemen, I feel that I have already trespassed on your patience. I would only say that if you would wish to obtain further knowledge of this most interesting subject, put in the most terse and pregnant way, you cannot do better than study a paper communicated to the Society of Arts by my

friend Mr. Preece—(cheers)—in which the details of this marvellous progress are set out concisely and perspicuously. But I do not like to sit down without reminding you that whereas a jubilee is generally a time of retrospect—and, indeed, we have a retrospect which I have endeavoured to trace, upon which we may look with more than pride and more than satisfaction—yet this moment of retrospect is only one of those in which a powerful and vigorous organisation draws its breath, in order to enter upon a new career. (Loud cheers.) Not only have we something to be proud of in the past, but I believe we shall have much more to be proud of in the future. This great agency which seems to form the vital principle of this planet upon which we live, this great agency which has not only gone so far towards annihilating space, but which seems at the present time to be regenerating light and revolutionising motion, has all the future before it. (Cheers.) Those who are enrolled in its service are probably the disciples and the apostles of a new and absolutely beneficial dispensation, and with them rests the future in no small degree of the human race—(applause)—and the means of linking not merely ourselves to our distant colonies—and my noble friend who is beside me (Lord Onslow) reminds me how important is the connection between England and the younger Englands beyond the sea—(cheers)—but by going forward in connecting the various races of mankind by binding island to island and continent to continent. The telegraph is doing in its own quiet, its own noiseless, and its own unobtrusive way, more than all the noisiest missionaries of peace and universal brotherhood have ever accomplished. (Applause.) The names which I ask leave to couple with this toast are those of Mr. Edwin Clark, who is, as we know, one of the veterans in the service of the electric telegraph, and of Mr. John Pender—(cheers)—who has made our English science cosmopolitan, and last, but certainly not least, the name of Sir William Thomson—(prolonged cheers)—who, I am proud to think, as a humble member of the same university, has done more than any other person connected with that ancient seat of learning and science to maintain its high reputation as one of the pioneers of scientific thought. Gentlemen with these three illustrious names I beg to couple this toast, and while thanking you for the patience with which you have listened to what I have ventured to say to you I venture to predict for this great science in whose honour we are gathered together here to-night another and much ampler jubilee whenever the next half-century enables it to take stock of the marvellous labours which it achieved for the benefit of the human race, for the development of human enlightment, and for the propagation of universal peace. (Loud cheers.) The toast was enthusiastically drunk.

Mr. EDWIN CLARK, who was applauded on rising, in the course of his remarks (which were uttered in so low a tone that they were heard with extreme difficulty, and at times were totally inaudible), said he had been selected for the honour of responding for the past of telegraphy, but he should confine himself to allusions to that which came under his own observation whilst he was connected with the Electric Telegraph Company. The arts and sciences had always been very closely associated, and it was often difficult to say where the one ended and the other began. This was exemplified in the case of telegraphy, which began as a pure science, but had eventually become almost completely an art. Now, however, it was becoming a science again under the fostering care of the clever and energetic men who were engaged in combining theory with practice. Having referred to the fact that Cooke and Wheatstone were the originators of anything like practical telegraphy on a large scale, Mr. Clark said it was he who introduced Wheatstone to Robert Stephenson. Stephenson at once took up the subject of telegraphy, foreseeing its value and importance. He granted permission for the line which had been erected for experimental purposes between Euston and Camden Town to remain. The first use of the telegraph of any importance was made upon this line. There had been previous telegraphing, of course, and he was not saying that Wheatstone invented the telegraph; he was only stating that this was undoubtedly the beginning of the practical application of the telegraph. Mr. Stephenson, having taken the matter up, for some years worked very assiduously for its development. In 1837, he (Mr. Clark) believed, he formed a company which came out as the Electric Telegraph Company. He was associated with some very eminent men—with Whitworth, of Manchester, Ricardo and others; they were capitalists and they found the money and formed the Electric Telegraph Company in that way. In the years 1846-7-8 he (the speaker) was employed in the construction of the Britannia Bridge and had nothing to do with the telegraph, but before he completed the bridge he was sent for to come to town in order that he might take charge of the Electric Telegraph Company, which was then working under very peculiar circumstances. He was told that the expenditure was very large, and that they were losing a sum of something like £50 or £60 a week. His instructions were to go into the matter carefully and investigate the affairs of the company and see whether it would be better to re-organise it or to abandon the undertaking altogether. He knew very little indeed of the subject, for he was not an electrician. But the question which was brought to him for solution was this—there was a certain number of lines and a certain number of customers, and there were certain expenses; could these be modified and so apportioned that the undertaking could be made to pay its way? When he and his brother (who was associated with him in the inquiry) came to look into the affair they found that very great economy could be effected in different ways. There was a great deal too much laboratory work going on at that time; there was nothing decided or known, no uniformity, the wires were of all sorts and sizes, and the materials generally were in a very precarious condition. The first thing was to put the instruments into proper workmanlike form, and to secure the proper insulation of the wires. The poles on which the line was suspended were of a very light character, were too small, in fact, and he brought down a number of excellent practical men from the Britannia Bridge to overhaul the whole concern. About this time he (the speaker) was engaged in negotiating with the whole of the railways with the idea of thoroughly working out the telegraph system. They were treated by the railway companies with very great liberality; they gave them rights of way, and even paid a portion of the expense of laying the telegraph company's lines. They found it so important to themselves that it was worth their while to give it their assistance, and there was such a demand for the telegraph that they could hardly execute the work fast enough. They laid down, generally speaking, a special line for the railway companies and a special line for themselves, it being understood that they assisted each other with their respective wires. They had a clerk in almost the whole of the stations, who was partly paid by the railway companies and partly by the Electric Telegraph Company, and whose duty it was to transmit the messages of the companies. That was the beginning of the commercial success of the undertaking, and it was entirely attributable to the railway companies. About this time he was deputed by the North Western Railway Company to examine the telegraph systems of Europe, and especially of Germany. From what he saw during that journey he recommended the adoption of a system which had now come into almost universal use, the block system. (Applause.) Their instruments and their wires were at that time of a very elementary character, and they very seldom tested the lines, for the reason that their testing instruments were not at all applicable for the purposes of durable telegraphy. But these matters were soon improved, under the supervision of the excellent staff he had around him. There were associated with him Varley, his (the speaker's) brother and Mr. Preece (the latter of whom he was glad to have introduced to the service). These and others turned their attention to the improvement of the apparatus, and so many alterations were made that in a short time the company was placed on a good sound footing. Having briefly referred to the earlier investigators in regard to telegraphy, Mr. Clark concluded by referring to the work performed in connection with submarine telegraphy by Mr. Jacob Brett, who was present at that gathering, but since whose first attempts were made, wonderful progress had taken place. (Cheers.)

Mr. JOHN PENDER, who on rising to respond on behalf of telegraphy in the present was loudly cheered, said: Mr. Raikes, my lords, and gentlemen. You have heard to-night a very admirable speech of our president, and he has given you in a very concise form the progress of telegraphy during the last fifty years. He has told you of the little telegram from Euston to Camden Town, and of the anxieties which attended those first moments of the telegraph; and he has also told you to-day that there are over fifty millions of telegrams passing over the telegraph lines of this country. I have been asked to speak of the present of the telegraph. In these few words I tell you what land line telegraphy is, and what it has achieved. My mission to-night is more to tell you what submarine telegraphy has done. (Applause.) Let it be remarked first that I do not speak as an electrician. I believe I am correct in saying that the great majority of this company are electricians, but I am one of those few commercial men who at an early period of telegraphy saw that there was in it the promise of a beneficent instrument for the future progress of the world. I have gone into submarine telegraphy, not as an expert, but as one of those who have come forward and taken Science by the hand, and led it up to the glorious results which we have seen. Twenty years ago there were only something like 2,000 miles of submarine cables; now there are 115,000 miles; and it has cost something like £38,000,000 or £39,000,000 sterling to put that amount of telegraph cable to the bottom of the sea. There was a prophecy long ago that the earth was to be girdled round in forty minutes. Why, we have got as much submarine telegraph cable as will go round the world five times, and we can send a message round the world in twenty minutes at the present moment. You ask me where does all this submarine telegraphy extend, and I reply in those beautiful lines of the poet:—

> "Far as the breeze can bear the billows' foam
> Survey our empire, and behold our home!"

Wherever the British ship goes, or the British flag flies, there we have the submarine telegraph; and at the present moment, while I am speaking to you, human thought is travelling like lightning to every part of the world. The future of that no man can tell. Of the 100,000,000 words which are now carried by submarine telegraphy, nine-tenths are for commercial purposes. You can conceive the amount of progress and the amount of benefit to the human race which follow the facilities thus given to commerce. I might talk for a long period of the advantages which telegraphy has given to politics, to commerce, and to social interest; but I will only say this, that if the progress of the next fifty years is as great as the progress of the last twenty, it will be the greatest marvel that has ever been known in this world. (Applause.) I know the value of time, gentlemen. I have been taught that in telegraphy. I know there are many much more important speeches to follow, and therefore I will not detain you longer than this. When the history of these fifty years of Her Majesty's glorious reign is written, telegraphy, and more espe-

cially submarine telegraphy, will be shown to have done more than anything else to federate the great colonies with the mother country, to spread civilisation throughout the world, and to make this great world of ours as near as possible one common country. (Cheers.)

Sir WILLIAM THOMSON then rose to respond and was greeted with an enthusiastic outburst of cheering. He said: Mr. Raikes, my lords, and gentlemen,—It is with feelings of a very mixed character that I appear this evening to speak for my fellow workers in the great work of the last thirty years of ocean telegraphy. I understand that it is ocean telegraphy in respect of which you have done me the honour of allowing me to speak this evening, because in the earlier part of the development of the telegraph I had no part; I have only recollection. But I do feel that when the telegraph has been so important a bond for all the nations of the world we ought to go even beyond our fifty years jubilee and think for a moment of the great names from other countries to whom the possibility of the jubilee of the electric telegraph has been due—the great apostles of electric science in France, Coulomb and Ampère—(Cheers.)—Ampère, whose work and whose discoveries constitute the foundation of the most important of modern telegraphic and electrical instruments generally, Ampère, whose name has become Anglicised and is invariably used in measuring the currents which produce the electric light. Then Gauss and Weber, who made the first electric telegraph. Mr. Edwin Clark justly and fairly expressed himself just now when he said that the telegraph of Cooke and Wheatstone was the first practical working telegraph, but he knew that others had worked in that field before, and that it was the practical realisation of their work we owe to our own great countrymen of whose splendid works he has spoken so ably. The telegraph of Gauss and Weber and the Munich telegraph of Steinheil, and the Steinheil key, which is the manipulating telegraph key of the present day—those were the elements of telegraphy. We justly rejoice that in England so much was made of the work of those grand pioneers in science. In America the race of practical work commenced almost simultaneously with our own in the splendid telegraph of Morse. In speaking of the telegraph we almost forget time and space, and I must go back to the previous work of Henry, who anticipated in some points some of the finest discoveries of Faraday, and laid a large part of the theory of current induction, which is at the very root of some of the most splendid realisations of modern electric science, not merely for the electric telegraph, but for electric lighting. But I am reminded that my own position to-night is to speak for my fellow-workers in ocean telegraphy, and in doing so I may say I have very mixed feelings. Most of them have gone away, few are here now, I am almost alone. By the work of 1857—a few years before the half of the Jubilee, the two brothers, Edward and Charles Bright and Whitehouse—those three men, with Mr. Cyrus Field, reduced to practice that brilliant dream of Cyrus Field to connect England and America by means of submarine telegraphy. Then there were the brothers Werner and William Siemens working in the same direction, and the great navigator Moriarty, who was out in the *Agamemnon* in 1857—I had the honour of being shipmates with him on the *Agamemnon*. He navigated the *Agamemnon* in 1868, and was on the *Great Eastern* as navigator with Sir James Anderson. In 1865 he picked up the cable where it was broken, and in 1866, coming back a year after to the same place, hit upon it just a quarter of a mile away by his splendid navigational powers. Canning and Clifford were also engaged in the work; then there were Varley and Jenkin (who was my special partner) with both of whom I worked for many years. I alone am here to speak for the three. Willoughby Smith, who did such fine work in 1865-6 in testing the cable, applying the newest developments of science, many of them his own inventions, to do what had never been done before, to test a submarine cable with the delicacy that was necessary under circumstances so peculiar, so utterly new. I am exceedingly sorry he is not with us this evening. I hope we shall see him many times more, upon some such occasions as this, and that he will soon recover from his temporary illness. But I can never forget that we scientists alone could not have done what has been done. I well remember the dead period of eight years, the middle of which was just the middle of our jubilee that we are celebrating to-night, the years from 1857 to 1866. We were on our backs, we could do nothing in science; the cable had been laid, it proved to be a success, it had delivered messages, a message had passed from the President of the United States to Her Majesty the Queen, and was answered by a gracious message from the Queen, and an important message countermanding the return of two regiments from Canada to England, in order to go to India to quell the Mutiny—the countermanding of the return from Canada was done by the Atlantic Cable of 1858. The Mutiny had happily come to an end, their presence at the end of the diameter of the earth, or pretty nearly so, was not needed, and the Atlantic Cable of 1858 conveyed the intelligence to them that they might remain in Canada. The cable failed, I do not remember at present how much money was spent upon it—half-a-million, I believe—and science could do no more. To two men, I believe, is due the existence of the 1865 cable, and all the consequences that followed from the 1865-66 cable—John Pender and Cyrus Field. (Applause.) With American spring, life, and energy, Cyrus Field flashed across the Atlantic—not by wire, though to our slow minds it almost seemed so—he was here trying to get up an undertaking somehow or other, trying to induce English capitalists and scientific men to join together. But one man, Mr. Pender, was steadfast to the work. He was a director in 1858 of the Atlantic Telegraph Company; he with some of his colleagues remained on, and with Cyrus Field persevered until the successful undertaking of 1865. I call it successful because it was really a successful undertaking although the cable was only half laid; it led, with further tremendous effort and self-sacrifice on the part of those devoted men and others who joined them to the great and enduring success of 1866. But I am asked to speak of the present time of telegraphy, and not merely of submarine telegraphy, and I must remember that there are other things besides ocean telegraphs. We have our land telegraphs, of which you, sir, have spoken. You have told us how splendidly the land telegraphs are worked; you have pointed out how admirably under the influence of the Government system, the application of science to telegraphy has been developed. I think you may feel proud, sir, in knowing that under Government management within these last 17 years the applications of science to telegraphy have not stood still, but on the contrary, have been pushed forward with every possible energy and with the most marvellous success. (Applause.) You have told us that the rate of working between Dublin and London has reached 462 words per minute, I think we may say 500 words per minute, and that is 10 times what it was 10 years ago. That is something for a Government department to be proud of, and for a Government I must say there is some little political importance in the fact that Dublin can now communicate its requests, its complaints, and its gratitudes—(laughter)—to London at the rate of 500 words per minute. It seems to me an ample demonstration of the utter scientific absurdity of any sentimental need for separate Parliaments in Ireland. (Laughter and Applause.) I should have failed in my duty in speaking for science if I had omitted to point out this, which seems to me a great contribution of science to the political welfare of the world. (Applause.)

The Rt. Hon. Sir LYON PLAYFAIR, M.P., who was loudly cheered, said: Mr. Raikes, my lords and gentlemen—The toast which I have been asked to propose to you is that of "The Scientific Societies." I am sure that is a toast which you will all welcome here. There is some difference between the scientific societies of the country and the peculiar habitudes of my friend who has just spoken. He is a remarkable example of a man from whom science and invention come from every alternate pore of his body. He is sometimes scientific, he is sometimes inventive: but the scientific societies do not profess invention. They profess to lay down the laws of science and to advance natural knowledge; and men who have contributed to advance natural knowledge like Oersted, Faraday, Ampère, and others, are as much the discoverers of the electric telegraph as if they had themselves actually aided in the invention, because the duty of the scientific societies is to cultivate the tree of knowledge. (Applause.) The tree of knowledge is one of slow growth. but in its time it produces the fruit of industrial invention. Those industrial inventions often—generally do—come by slow degrees, and it is very difficult often to say who is the first and true inventor of any particular contribution to industry. It is very rare—indeed, it is never the case—that a great invention which changes the face of society, comes suddenly to the world as Minerva came out of the brain of Jupiter, panoplied and full armoured. But recollect that even Jupiter could not do this till he had swallowed the mother of Minerva, Metis, in the first month of her gestation, and then the gestation took a prodigious time, and afterwards there was the remarkable demonstration of Minerva coming out panoplied and full armoured. Now this is what inventors do. After science has gone through a proper process of gestation in their bodies, then come out their inventions slowly and by degrees, so much so, that even in the case of a great invention like the steam engine, which is the only thing comparable with the electric telegraph in the influence it has had on the progress of the world, one of the highest courts of justice in this realm has decided, after reviewing all the steps in the advancement of the steam engine, that Watt contributed nothing at all towards it. (Cheers.) It is the same with regard to telegraphy, one does not know when the electric telegraph was first invented. There was one little incident that I may mention. Many years ago I was dining at the mess of the Artillery at Woolwich, and Professor Wheatstone was one of the guests. I forget what the toast was, but it was something connected with his discoveries in electricity, and I described him in my speech as the discoverer of the electric telegraph. At that time Wheatstone and I lived within a few doors of each other, he on one side of Hampstead bridge and I immediately at the other, and we always went home together and he censured me for my foolish speech. He said that he was not the discoverer of the electric telegraph—that Oersted and Faraday were its true discoverers, for it was from their discoveries that electric telegraphy had originated. He admitted that there had been many experiments in telegraphy before his day, but he claimed with pride that he had done a great deal for the practical promotion of telegraphy, and for the instruments which he had invented in order to promote them. Now the scientific societies to which I ask you to drink have for their duty the advancement of natural knowledge. Wheatstone himself was more proud in advancing natural knowledge than he was even in advancing telegraphy, because he knew that it was by laying the foundation of science on a sound and firm basis that we are able to make inventions and applications of that science which do so much for humanity. (Applause.) It is natural that we are struck in telegraphy with the almost practical annihilation of time and space. That strikes our imagination; but what

telegraphy has done for the world is incalculable, not only in adding largely to the resources of government, but in having profoundly changed the whole practice of commerce all over the world. (Hear, hear.) Capital which was formerly used in one way has now to find completely different outlets for its utility. The system of exchange has been entirely altered, and the sons of merchants of 50 years ago no longer carry on their business by any of the traditions of their fathers. The whole system of commerce and goverment has been altered by telegraphy. Now then the lesson—and it is the last thing I want to say—the lesson which telegraphy teaches us is this, that while we should rejoice in invention we should never forget that science is the mother of invention, and that we should sympathise with every effort to promote the advance of natural knowledge. I am sure it is not necessary here to answer any of those stupid questions which 40 or 50 years ago were asked of scientific men. "*Cui bono?* what is the use of your abstract discovery? It has no relation to the utilities of life." You recollect how Faraday answered that by asking another question. When somebody asked him what was the use of some abstract discovery he had made, he replied by saying, "What is the use of a baby?" (Laughter.) But round that baby are all the hopes and all the future aspirations of the parent. It contains the potentiality of good and of evil, and even the State interferes on its behalf by bringing in legislation to make it a good and useful citizen. Therefore we should, in regard to all discoveries, however unimportant they seem, do everything to promote their growth and to promote the growth of natural knowledge throughout scientific societies, not only in this country but all over the world, and therefore I ask you to drink this toast, and I beg to join with it the name of one of the most distinguished scientific men in this kingdom, Professor Stokes, the president of the Royal Society, and also the name of Dr. Gladstone. (Cheers.)

The toast having been cordially drunk.

Prof. STOKES said: Mr. Raikes, my lords and gentlemen,—Considering the nature of the present occasion it might, perhaps, be expected that I should say something of the practical application of scientific studies to the ordinary purposes of life, but I am sure it will be thought unnecessary that I should say anything on that topic. Every electrician present, of whom there are so many, must know that the practical applications of electricity could not be what they are were it not for the investigations of scientific men—of those who perhaps have studied electricity from a purely scientific point of view. Therefore in the few words with which alone I intend at this late hour of the evening to trouble you, I propose rather to refer to the reciprocal benefit which the study of abstract science has received from the labours of those who have applied science to the wants of life. Scientific men know well how fascinating is the pursuit of science. Some have even gone so far as to consider that it would be polluted, if I may so speak, by being applied practically. An eminent foreign mathematician delighted in the theory of numbers because one could not conceive that it could have any practical application. An eminent English mathematician I heard express a somewhat similar sentiment, and I dare say Sir Wm. Thomson may remember it, for the three of us were together on that occasion. All honour be to those who are so immersed, if I may so speak, in abstract science, that they disregard and even dislike its application. They pursue science with all the more zest, they pursue it in directions which possibly otherwise might not have been followed out, and possibly in the end their own investigations may admit of applications which they never dreamt of. But for my own part my tastes do not quite lie in that direction. I like to see science connected with applications thereof, no matter to what purpose—(hear, hear)—and I think that my friend Sir Wm. Thomson has tastes similar to my own in that respect. Now when we apply abstract science to physical subjects, we are not only enabled to investigate natural phenomena in a manner which could not otherwise be done, but the study reacts on the most abstract parts of science, and enables us sometimes to see as if it were by intuition truths of an abstract nature, such as, for example, propositions in pure mathematics, which we, perhaps, should never have arrived at if we had not viewed them through the spectacles, so to speak, of their physical application. But this is not all. When science comes to be applied to the wants of life, scientific men are placed by the practical man in the condition of making experiments which oftentimes would otherwise be impossible. When science comes to be applied to commercial purposes, it then becomes possible to construct instruments on a scale the expensiveness of which would have been utterly prohibitory to the purely scientific man. (Applause.) But when these instruments are constructed, it may be, for commercial purposes, the scientific man on his part is able by the favour of those who have constructed them, or by those for whom they have been constructed, to make experiments with them which oftentimes are of great interest from a purely scientific point of view. (Hear, hear.) I remember the interest with which I read some of the experiments which Faraday made by means of a cable which had been constructed for crossing the Atlantic, though as yet it lay in its tank. The theory of this is now well known, and my friend on my left, Sir William Thomson, has been one of the foremost in investigating it, but then the subject was scientifically in its infancy, and I do not know how far or how fast it might have progressed had it not been for the facilities for scientific investigation which have been placed in the hands of pure scientists by those who constructed those instruments for the purposes of commerce and the general objects of life. Gentlemen, at this late hour I will no longer detain you, but thank you for the honour you have done me.

Dr. GLADSTONE, responding on behalf of the Royal Institution, said he felt it was no small honour to take part in the proceedings of so interesting a gathering. He was sincerely sorry that Sir Frederick Bramwell, who was to have responded to the toast, was unable to be present to delight and instruct them with his genial wit and wisdom. As far as the Royal Institution was concerned, of course it was not the Royal Institution which had been spoken to in the toast, but rather those members connected with it in reference to telegraphy and electric science. At the Institution there were not merely memories binding them to all those who had passed away, but they had also many relics. They preserved the log books of Davy, Faraday, and others, and not only that, but there was a great number of pieces of wire, sealing wax and card, all damaged, and many other things which Faraday especially used to delight to work with and to carry out in the first experiments which were suggested by the ideas that were working in his brain, and these were preserved as germs of some of their great discoveries. They had there, for instance, a small range of soft iron, with iron wire twisted round it, insulated by calico, and tied up with string, from which he obtained his first electric effects from magnetism. (Applause.) He mentioned those things because they had already had brought before them, in one form and another, many ways in which the electric telegraph had been traced back to its original germs. And here he wanted to point out one of those germs connected with telegraphy. Those relics preserved at the Royal Institution were only worth originally a few pence or shillings. How different the monster wealth which had now become the capital of those great enterprises! As far as the Royal Institution was concerned, its connection with the electric telegraph was to a certain extent not direct, and yet it was very real. Sir Humphry Davy worked there of course largely on galvanic electricity, but he belonged to the pre-telegraphic era. Faraday himself commenced to work early on these matters, and continued to try and image in his own mind what was taking place in these phenomena. And he always marvelled at the results arrived at, even when he knew more than anyone else what took place. He seemed to have been constantly wrapped in his experiments, and his enthusiasm took him forward from discovery to discovery, all tending to show connections between the different branches of electricity and the various forces with which they were acquainted. It had already been remarked by Sir Lyon Playfair that Faraday was a discoverer, and did not care much for invention. There were some like Wheatstone and Sir William Thomson who were distinguished in both departments, but it was not given to very many to be so. Faraday gave the whole of his life to investigation and development; but, while he did that, he also encouraged those who were working in practical applications. It was an important point with him that the glories of science should conduce to the benefit of man. They knew his influence with Sir Charles Wheatstone was very great, and he got him into the dark chambers at the Royal Institution and talked to him about his investigations, and in the theatre brought before him some of those experiments which were afterwards performed with so much success in public. In one way and another Faraday had to do with the industrial applications of electricity, as well as with scientific discovery. One of the very earliest experiments of Faraday that led to some of his discoveries was in relation to Ampere's experiments, and they had a record of how delighted he was when he found that he was able to produce not only the effects of the wire revolving round the magnet, but of the magnet revolving round the wire; and how he revolved round the whole of his experiments, and declared he would do no more work on that day. (Applause.) In another reminiscence they found him thinking of what could be taking place in the dielectrics, and getting out what was retarding the force, and what was enabling the force to propagate, until, at last, he conceived the idea of specific inductive capacity. They knew how that was taken up by Sir William Thomson and others in various ways, and led to a number of other interesting discoveries. (Applause.) Those were the trophies of early electrical discovery; but electrical discovery would have been of very little use if it had not been that others came in and took up those discoveries and applied them. They had the combination of the purely scientific man with the practical man, and then the two going together with slow, careful, conscientious investigation, followed by the energetic carrying out of the discovery in a form which benefited mankind. (Applause.)

Mr. SHAW-LEFEVRE, M.P., said: Mr. Raikes my lords and gentlemen,—I feel highly honoured by being called upon to propose to you the next toast and I shall best show my appreciation of that honour by ruthlessly cutting down by three-fourths what I had intended to say to you for at this late hour of the night, you are doubtless anxious to get away. I am, gentlemen, I am sorry to say, just old enough to recollect, if not the birth of telegraphy, at all events, its earliest infancy for I have a vivid recollection of having been taken by my father when a boy to the house of a friend where Professor Wheatstone set up a model of his invention and where it was explained to us by Professor Wheatstone himself and Faraday. It impressed itself on my mind the more because, although I understood very little about it at the time, I recollect my father saying that I had seen two great men on that occasion, and a great invention, the end of which nobody could predict. When I was a boy, at Eton, I recollect well the extension of the telegraph from London to Slough and of an incident of which you are all aware, the arrest of Towell, which I believe brought the telegraph more into notice than anything else at that time. It might have been expected that the autho-

rities of Eton, seeing a great invention of this kind brought to their door, might have been desirous of explaining it to the boys of the school, and might have been drawn out of their deep slumber of ages and done something for the scientific education of the boys then at Eton. But no thought of the kind ever entered into their minds, and the only notice taken of it at the time was that they set it as the subject for Greek verses. I and all the boys of my class commenced racking our brains to write some Greek iambics upon a subject of which we knew nothing, and to bring it into connection with the mythology of the ancients, of which we knew a good deal. (Laughter.) I refer to this for the purpose of showing you how little science was promoted then at our public schools. I am glad to say that things have been changed since then—(cheers)—but much has to be done in this direction, and there cannot be a doubt if this country is to hold its own in the great industrial competition it must give a greater place to science in our schools, and equalise the endowments between the classical and scientific studies—(cheers)—and it is only by doing that I am persuaded that we can hold our own. But if I give a warning upon this point, do not think that we are otherwise than proud of the past in respect of science. Sir Lyon Playfair has already spoken of that branch of scientific men who devote themselves to pure science. It is my duty to propose the toast of that class of scientific men who devote themselves to that part of science connected with the industries and commerce of this country—(applause)—to the mutual advantage of both, for if science has multiplied the commerce and industry of this country a hundredfold, it owes itself a great deal to the industries of this country, and many discoveries would not have been made if it had not been for the important impetus which the industry of the country has applied to them. (Applause.) I doubt whether there is any country in the world where there is a more devoted band of scientific men devoted to the branch I speak of—(hear, hear)—and in the two great societies, the Civil Engineers and that devoted to telegraph engineering, we have two bodies of men who have conferred inestimable benefits on the country. The one has supplied the country with all its railways, and has carried the capital of England to every part of the world, and has constructed railways in India and given the model of them to many other parts of the world. I need hardly say that the telegraph engineers have given to England a monopoly of submarine telegraphy throughout the world—(cheers)—which has been an enormous advantage to the country. I beg, therefore, to conclude by proposing "The Societies Representing Applied Science," and to couple with it the names of Mr. Bruce and Mr. Latimer Clark. (Cheers.) The toast was duly honoured.

Mr. BRUCE, in responding, said: My lords, and gentlemen,—There is manifest fitness in the arrangement by which the recognition of science takes precedence to-night of the recognition of the application of science. It is in the latter and humbler walk that the engineer may be said to tread. The student of pure science follows it for its own sake. He dives into the mysteries of nature for the pure love of making it reveal to man something which he did not know before—(hear, hear)—a lover of seeking rewarded by the satisfaction of finding. The engineer, on the other hand, is the humble attendant upon the man of science, and when this man of pure science reveals some new law, then it is clearly our duty to try and find out some means by which that addition to the world's knowledge may be made to add to the world's wealth and happiness in things material. I think, gentlemen, we also have been very successful in the past in this department of the world's work, and we need no other testimony with regard to that than the position of telegraphy to-day, with the marvellous changes which it has wrought in the social life and in the commerce of the world, as we have heard early this evening from so many speakers. In fact, there is not the least doubt of it that the most marked feature of the reign of our most gracious Queen, and that by which it will be distinguished all down the ages, is the application of science upon both sea and land in order to ameliorate and lessen human labour and to make the powers of nature work for man. (Applause.) That you have coupled to-night with this beneficent enterprise the Institution of Civil Engineers, which I have the honour to represent, I heartily thank you. We have faith in our mission, because although the instrument which the engineer may be said in the main to use for the advancement of human progress is iron, still we think we see in the forecast of the future indications that the golden age is before and not behind us. (Applause.)

Mr. LATIMER CLARK, who was received with cordial applause, also responded. He said: My name is associated with that of the President of the Institution of Civil Engineers because I am intimately acquainted with the history and development of the Society of Telegraph-Engineers, and because the subject which the telegraph-engineers have taken to themselves is one which is specially interesting in connection with the present Jubilee. Now, the society, as most of us know, began in the year 1872, and was founded by the late Col. Sir Francis Bolton, whom we all deplore, and by another gentlemen, who, I am happy to say is with us to-night, Major-General Webber. (Cheers.) The society has had a career of great prosperity and success. It has increased in numbers, in popularity, and in usefulness day by day, and I am happy to add that its finances are in a sound and satisfactory condition. (Applause.) But it is not by success and prosperity that we are to measure its importance; we owe our importance on the present occasion to the fact that we are connected with the science of electricity, and that we deal with a fluid or power which has the most wonderful properties. Those properties are little understood and little known, but the importance of their application is obvious to all mankind. In the first place, electricity is marked above all things by its wonderful power of propagation. It has a mysterious connection with all the other forces of nature—energy, light, and heat. There is a charming simplicity about its laws which has engaged the attention of all the scientific men of the period. We produce results which are apparently marvellous in the eyes of mankind; we produce effects which are most brilliant. We are able to utilise the powers of this wondrous fluid or power for almost all the purposes of life; and, lastly, there lies before us obviously an unknown future, but one which must have great importance to mankind. It is a fact that it is this peculiar agent which gives our society the importance which I feel it possesses. It is natural that the society should have lost many of our members. I have to deplore the loss of some men whose names are on the pages of history. I need only allude to such names as those of Cooke, Wheatstone, and Morse, and other men equally well-known to you—Ronalds; we cannot name Faraday as one of our members, but he is one of those who have gone before in this matter. I am happy to feel that we have here to-day other names which are equally splendid. We have with us this evening one man who by a singular fatality is not a member of the society, but who certainly ought to be—we have with us this evening Mr. Jacob Brett. (Cheers.) He undoubtedly is the father of submarine telegraphy,. We have heard stated with great eloquence this evening the result achieved by submarine telegraphy; we heard from Mr. Pender the wondrous extent to which it has been carried; we have heard from Sir William Thomson, with his usual eloquence, the marvels of the Atlantic telegraph; we know that the highest honours have been deservedly bestowed upon those who were connected with it, but by some accident we have forgotten that before the Atlantic telegraph existed there were such things as submarine telegraphs, and that the submarine telegraph had arrived practically at full perfection, and the men who had brought it to that perfection were Mr. Jacob Brett and his brother, associated with others who deserve equal honour and credit. (Cheers.) The Atlantic telegraph itself was brought into existence through the efforts of the brothers Brett, and I think we do an injustice to the science of electricity and to the art of submarine telegraphy when we forget them in the history of the subject. There can be no doubt that some seven years before the Atlantic telegraph they had successfully laid and put into working order a system of telegraphs which was in every respect the type of all the telegraphs of the present day. Therefore I say we are doing an injustice if we do not remember that these men were the real pioneers of sub marine telegraphy—(cheers)—if we do not remember also that when the centenary of submarine telegraphy comes forward in 1950, the names of the Bretts must be prominent as the originators of submarine enterprise. (Applause.) I had forgotten the name of Siemens; I do not know why, for I intended to refer to it. No greater name will go down on the roll of famous scientific men. (Applause.) There is one other subject I would mention to you. In the circumstances of life I have been entrusted with a number of valuable documents connected with the history of electric telegraphs. I was entrusted by Sir William Cooke with all his private papers and letters on the subject; I have been entrusted by Mr. Jacob Brett with all the interesting documents which he possessed connected with the establishment of submarine telegraphy; I was entrusted by Prof. Morse with some of the earliest specimens of his inventions connected with the electric telegraph, signed with his autograph. I feel that I have arrived at a period of life when it is prudent that I have arrived at a period of life when it is prudent that I should relinquish that charge, and I now desire to state publicly my wish to hand those documents over to the Society of Telegraph Engineers. (Cheers.) I might now have ended by merely thanking you in the name of the Society of Telegraph-Engineers for the very kind manner in which you have received the toast; but the toast is that of the societies which are connected with applied science, and when I think of that toast I am emboldened by the patience with which you have listened to me to make one other remark, which shall be a very brief one. I feel that we, as the representatives of applied science, have been somewhat neglected by the world. I feel that the politicians, some of whom have honoured us by coming here this evening, have very much neglected us. I don't allude to honours, for we shall be very well content with the position of things in that regard; but I feel that they have robbed us of much of our credit for the fact that the great effects of the jubilee which we are now assembled to commemorate have been due to the agency of the applied sciences. I do feel that politicians have been permitted to claim for themselves the credit for the wondrous benefits civilisation has received from the efforts of applied science. We hear that so many shillings have been taken off a quarter of wheat, we hear that all the prosperity of the country has been due to free trade, but I say it is not so, I say they have robbed us of our honours in saying that, I say as guild and craft we ought to proclaim loudly to the world that to our efforts most of all the prosperity of the last 50 years has been done. (Hear, hear and cheers.) The population of this great city and of this country when it eats its breakfast to-morrow morning will be consuming food, a very large proportion of which has been brought to this country by means of applied science. It is that which has given us our prosperity. They have not taken 5s. or 10s. a quarter off wheat and corn and eatables, but they have taken off 60s., 80s., and 100s. Wheat will be brought to-morrow from places from which it could not have been brought 50 years ago for ten times what it now costs. As a

guild and craft we ought to proclaim loudly that the benefits which we have conferred are the real cause of the prosperity of the great Victorian era which we meet here to celebrate. (Cheers).

The EARL OF ONSLOW: Mr. Raikes, my lords and gentlemen,—I am sure that you will be glad to hear from me the announcement that to my hands has been entrusted the last toast of the evening, but although it is the last toast it is by no means an unimportant one. It is that of our chairman this evening, the Postmaster-General. (Cheers.) Mr. Raikes is the head of the most important system of telegraphy in the world. It is true he is only the temporary head, and I, for one at least, hope that he or one of his own political complexion, may long occupy that place. (laughter.) But, gentlemen, it is not only in my own private and individual capacity that I am anxious to say a few words upon this jubilee celebration of the electric telegraph, but also as representing that department of the Government with which I have the honour humbly to be connected, I mean the Colonial Office. (Hear, hear.) Much has been said during the present year of the desirability of drawing together the bonds of the mother country and her Colonies—(Applause)—but I venture to say that of all those bonds there is none so efficient or so strong as those of copper and gutta-percha which the science of telegraphy has invented—(Applause)—and I am anxious to take this opportunity of expressing my gratitude to Mr. Raikes for the assistance which he rendered to us during the sittings of the late Colonial Conference, in doing all that lay in his power to draw together the great commercial interests of England and of her Colonies by means of communication by post and telegraph. I feel that in Mr. Raikes we have to-night a gentleman who has not only presided over us with very great dignity and efficiency—(applause)—but also one who has deserved well at the hands of his country in administering that department which contributes most to the welfare of the great commercial world, of which the metropolis in which we are this evening seated is I am happy to think the centre. Gentlemen, I give you "The health of Mr. Raikes, the Postmaster-General." (Cheers.)

The toast having been cordially drunk,

The CHAIRMAN said: Lord Onslow and gentlemen, I have to thank you very sincerely for the very kind manner in which this toast has been proposed and received and I can only say now, as I have said previously in the evening, that I feel that your kindness is much greater than I deserve, I can only say that in departing from a subject of such magnitude and such universal interest if one has not the knowledge of an expert, at least one can bring to it something of sympathy and something of humanity. (Hear, hear.) I have sat here this eveving and listened to the speeches made by some of the most eminent men of our time. I have heard recounted some of the achievements of the heroes of this great and peaceable crusade, and I have come to the same conclusion as that recently enforced upon us by Mr. Latimer Clark that it is rather to the men of Science—may I say especially to the men of applied science—that the prosperity of this country during the last 20 years has been due than to the politicians of that epoch. (Laughter.) I feel that it is one of the special advantages of the office which I have been called upon to hold that one comes to realise more fully than one otherwise might the great forces which are working under the surface of our complex society, and to realise how little is done by Parliamentary chatter or by political agitation, compared with the great, unmarked perhaps, but resistless progress of the human mind—(cheers)—which is perhaps embodied in no particular aspect more thoroughly than in the progress of the telegraph system which we have met to celebrate. (Cheers.) I have to thank you extremely for your kindness to me. Perhaps you will allow me before I sit down to read to you a telegram which has only just been placed in my hands, and which I think is a fitting climax to the festivities of this evening: "Kindly convey to Chairman of Jubilee Dinner the following from the Cape of Good Hope telegraphists—Heartiest congratulations and fraternal greetings on Jubilee of Telegraph." This at least is an evidence, not only of the extension of telegraphy, but of the fraternal and cordial feeling which that extension entails, and I am indeed proud to be here here to-night in the midst of them in assisting to celebrate this great and never-to-be-forgotten Jubilee. (Loud cheers.)

ELECTRIC TRACTION.

OPERATIONS of a most important character in the electrical equipment of tramcars have for many months been carried on by the Electric Traction Syndicate, Limited, at Southwick, near Brighton. Through Southwick runs a tram line which was constructed by the Brighton and District Tramway Company, and extends from the western boundary of Hove to Shoreham, a distance of 4¼ miles. The use of this line has been acquired by the Syndicate for its experimental trials, and owing to the road being about as bad as it could possibly be, and having a variety of curves and gradients, the engineer considers it an excellent bit for the purpose. The sharpest curve is one of 30 feet radius, and the steepest incline 1 in 20. So completely have all practical difficulties now been surmounted that the Syndicate are giving public demonstrations of it, and is prepared to arrange with tramway companies on the principle of working their cars with electric traction in place of horses, at a saving to the companies of at least a halfpenny per mile run, the Syndicate taking all risk and responsibility. The system adopted is that of working by accumulators, those now in use being of the Tatham type. At a special demonstration on Tuesday last, illustrations were given of two distinct methods of traction. The first was by means of an electro-locomotive specially built to meet certain requirements, and called by the owners "The Electromotive." It consists of a frame of rolled angle iron, strongly braced and stayed, supporting three platforms, on which accumulators are lodged in sliding cradles. The springs and axleboxes are designed upon the waggon pattern, to carry about 13 tons per wheel. The motors, which are of the Immisch type, series wound, having a speed of 650 revs. per minute, and armatures 9" in diameter, gear direct by pinions at each end of the armature spindle into internal tooth gearing fixed on the inner surface of the wheels, which are three feet in diameter, the proportion being 10 teeth of the pinion to 67 teeth of the wheel.

The motors are suspended by sleeves on journals cut in the axles, which are of steel, and have a tension bar from the centre of the fields to the end-framing bar to act as a fulcrum. The motors independently can exert a power of 15H.P., and together 30H.P., which is amply sufficient to draw a bogie car with 60 passengers at a mean speed of 8 miles per hour. There are 168 A size Tatham cells in all on the platforms, divided into two groups placed at each end of the car, but separated by a well in which the driver can get to attend to the motor whilst running. The motors can be made to run in series, in parallel, or independently, as required, being controlled by a special form of locking switch designed and constructed by Messrs. Immisch and Co. By this switch also the discharge of the accumulators in half series or parallel can be controlled, resistance being automatically introduced in starting.

The present design of the electromotive is surmounted by a canopy, which in practice would be superseded by sitting space for 14 people, making a passenger load with the bogie car of 74 seats.

The gross weight of the electromotive is about 12 tons, the accumulators each weighing 56 lbs., inclusive of connections, and being capable of a discharge of 70 ampères, having a capacity of about 200 ampère hours. The mean working discharge for draft of 20 tons—that is, electromotive and bogie car together, at 8 miles per hour—is about 40 to 55 ampères per cell, and the electromotive under these conditions accomplishes 25 to 30 miles in distance (practically half a day's work) without requiring to be recharged.

In the present design the accumulators are not intended to be withdrawn, as experience shows that the Tatham form of cell adopted admits so fully of the economical absorption of a large current in charging, that during the time one electromotive was at work the spare one could be charged.

The other form in which the application of the system was shown consisted of an ordinary one horse tramcar, the sides of which had been altered so as to allow of the package of the accumulators under the seats from the outside, and the flooring reconstructed to allow of the motor being fixed in position. The weight of the car was stated to be 1 ton, the motor and gearing 1 ton, the accumulators 1½ tons, and estimated weight of 20 passengers 1¼ tons, making a total rolling load of 4¾ tons. The motor is an Immisch series wound, and runs at 1,000 revolutions with 160 volts and 40 ampères. The high speed has been determined upon after experiments which showed that a light motor running at a moderately high speed is superior to a heavy motor running at a low speed. A motor running at 350 revs. per minute was first tried, and it was found that the torque was so great as to necessitate a comparatively heavy motor, and that since the gearing and motor supports had to be correspondingly strengthened the rolling load was seriously increased. Moreover, the efficiency of the motor was reduced considerably, and the current required for starting and on inclines damaged the cells and reduced the duration of charge. The present motor weighs 5½ cwts. and has an efficiency of conversion at full load of over 85 per cent. Its average working efficiency is probably about 75-80 per cent. It is capable of exerting a pull of 1,000 ibs. on the periphery of the armature without risk. This enormous torque does away with fear of the motor sticking at starting, and the car has been stopped and started on an incline of 1 in 20.

The reversing gear comprises two sets of brushes and is worked either by lines or levers; it is of first class mechanical design and locks the brush frame positively in either direction.

The Tatham accumulators on this car weigh about 40 lbs. per cell when charged, each having a capacity of 150 ampère hours with a fall of potential of 10 per cent., admitting a sustained discharge of 50 ampères. The car has 80 cells. They are arranged in two groups of 40 cells each, and can be coupled in series or parallel. The arrangement of coupling is necessitated by the condition of running, viz., a fixed maximum speed and a variable load. A resistance is inserted in the circuit and is used when starting, or when it is necessary to run very slowly. A charge is sufficient for a run of about 30 miles, but it is not proposed to exceed 25 in practice.

The gear is a double tram transmission by chains and wheels. The intermediate shaft was found necessary owing to the large reduction of speed—1,000 revs. on the motor to about 100 on the rolling wheels. If a single tram transmission had been used, the pinion would have been so small that the chains would have been seriously strained and its life materially shortened, and, moreover, it would have been more noisy.

A METHOD OF TESTING SECONDARY GENERATORS.

By DR. LOUIS DUNCAN, Johns Hopkins University.

In testing apparatus of high efficiency, it is better, providing the measurements can be made with approximately the same accuracy, to measure the loss and the total energy absorbed, than to calculate the efficiency from measurements of the total energy absorbed and that given out. For instance, if A_f is the energy absorbed; A_e that given back; and l the loss; then if we measure the first two we have :—

$$\text{Efficiency} = \frac{A_e}{A_f};$$

if we measure the last and either of the first we have

$$\text{Efficiency} = 1 - \frac{l}{A_f}, \quad \text{or,} \quad 1 - \frac{l}{l + A_e}$$

In the first case, any error in either of the measurements would enter almost directly in the result; in the second, providing the efficiency be high, errors in the measurements would have comparatively little weight. For example, if the efficiency were about 90 per cent., then by the first method an error of 10 per cent. in A_e or A_f would cause an error of about the same amount in the calculated efficiency. But by the second method 10 per cent. error in l or A_f would only cause about 1 per cent. error in the efficiency.

With secondary generators it is not difficult to measure the loss. The apparatus could be sealed, to prevent water from injuring it or short-circuiting the coils, placed in a vessel, the radiation from which has been experimentally determined, and then water could be allowed to flow through uniformly, the temperatures of ingress and egress being noted and the escape water weighed. There should be a stirring arrangement to keep the water in the vessel at a constant temperature throughout, and this temperature should be known, as also the work expended in stirring.

After a time the arrangement will settle down to a state of equilibrium as regards temperature, and if

$t°_i$ = temperature of ingress,
$t°_e$ = " " egress,
t_o = average temperature of vessel,
t_a = " " " air,
a = coefficient of radiation,
J = mechanical equivalent of heat,
H = work expended in stirring,
W = weight of water,

we have :—

$$l = W J \left\{ (t_e - t_i) + a (t_o - t_a) \right\} - H.$$

The other quantity necessary to calculate the efficiency should be the energy in the external circuit of the secondary, preferably measured by a calorimeter. Thus :—

$$\text{Percentage efficiency} = 1 - \frac{l}{l + A_e}.$$

I am not aware that this method has ever been tried, and it is easier to write this than to look up the not very extended, but rather diffuse, information on the subject.

ELECTRIC INDUCTION AND TRANSFORMERS FOR ELECTICAL DISTRIBUTION.

At a recent meeting of the Franklin Institute, there was shown a small model of a secondary induction coil which had been used a few days previously in the Institute lecture course. It was intended to show, in a crude way, the general principle of induction of one current by another, and particularly the induction or generation of a current of great quantity but low pressure, by means of one of small quantity but great pressure, this being the system introduced some years ago in Europe and lately brought into this country.

The system is used chiefly for incandescent electric lighting at a distance. The currents required for such lighting being of great quantity and of low tension, the transportation of such currents, by means of wires from the generating station to the consumer, is accompanied either by a great loss of power in the mains, or else it necessitates great expense in the first cost of the mains, which, when considering the interest and depreciation, is equivalent to a running expense of no small amount. In a system of induction coils, or "transformers," as they are generally termed, the energy is transported in the form of a small current of very high tension, in which form it may be led great distances along a comparatively small conductor, without any great loss, as the size of the wire is to a certain extent proportional to the current, but independent of the pressure. Such currents, which would be useless in this form for incandescent lighting, are converted or transformed at the consumers by means of these induction coils, into currents of great quantity by low tension.

These transformers are in principle mere Rhumkorff coils reversed, the primary current being of high tension and small quantity, and the secondary the current of great quantity. In detail, the apparatus shown differed greatly from the Rhumkorff coil, which, in the usual form, would be very inefficient. It consisted of a coil 8½ inches mean diameter, of 127 turns of No. 16 B. & S. wire, weighing 4 lbs. The coil was taken just as it came off the reel, and bound with tape and shellaced canvas so as to have a circular cross section. Next to this was placed a similar ring of very thick wire, consisting of eight turns of No. 3 B. & S. wire, weighing 3 lbs. 5 ounces, the diameter of this ring being the same. These two coils were then bound together and wrapped with 11½ lbs. of fine, soft iron bell-hanger's wire.

As the induction of currents in a neighbouring wire takes place only with changes or reversals of the primary current, this primary current must either be intermittent or alternating. As the former is accompanied by destructive sparking, the latter is the only practical form of current to be used in practice.

When the apparatus was exhibited, an alternating current from a small Gerard machine was passed through a small German silver wire, No. 22, and into the fine wire coil. Upon connecting the coarse wire terminals with a similar German silver wire, it was instantly fused, showing that the same energy which passed through that fine wire in the form of a small current of high tension was transformed into one of such great quantity as to instantly fuse a similar wire. The same current was strong enough to fuse several strands of heavy iron wire, and to melt into a globule a 3-inch wrought iron nail.

Owing to the want of suitable measuring instruments, no quantitative tests could be made. As the only possible loss in such a coil is the heat developed in the copper wire due to its resistance, and the heat developed in the iron due to changes of magnetism and Foucault currents, it was quite correct to conclude that, as the coil kept quite cool, the efficiency was very high.

The generation of a current in such a coil may be readily explained on the same basis as the generation of currents in a dynamo. In the latter we know that when a wire passes through or "cuts," as it is termed, magnetic lines of force, a current will be generated in that wire. In the dynamos, the wire is moved mechanically nearer a magnet. In the transformer, as well as the Rhumkorff coil, it is the line of force or the magnetism which moves, as it might be called, across the wire. This may be understood as follows. Every current is encircled by numerous lines of magnetic force, as shown in the galvanometer and electromagnet. These lines decrease in number as they are farther from the wire. A few years ago the writer called attention to the fact that all the well-known laws of the mutual action and induction between currents could be explained by their lines of force. The attraction and repulsion of like and unlike currents could be explained by the attraction and repulsion of these invisible lines of force. The induction of a current in a wire, which was moved towards or away from a current, was explained by the cutting of the lines of force around the current by the moving wire. When a current is started in a wire the lines of force, being proportioned in number to the current, will at first be very small circles around the wire, and as the current increases, these circles will grow larger; they may be said to be similar to the circular ripples produced on the surface of a still pond when a stone is thrown into the water. It is evident that a wire lying parallel to the first, and near to it, will be cut by these emanated lines of force, and, therefore, a current will be induced in it. From the laws of induction and of cutting lines of force, the direction of the induced current can be shown to be that actually observed. Similarly when the current was stopped, these lines of force came together again like a stretched rubber ring, and thereby cut the neighbouring wires again, but in the opposite direction, thus inducing a current in the opposite direction. By thus considering the mutual action of currents as being merely the well-known action of the lines of force encircling the currents, the induction of currents in the Rhumkorff coil was readily explained without the use of Ampère's laws of the mutual action of currents, or of Faraday's and Lenz's laws of induction.

The induction of currents in a transformer is, therefore, explained by the simple laws of cutting lines of force; when two or more wires lie parallel, and are encased in common by a sheathing of iron, the lines of force emanating from a primary wire when a current is started in it, cut the other wire, the secondary, in passing to the iron sheathing.

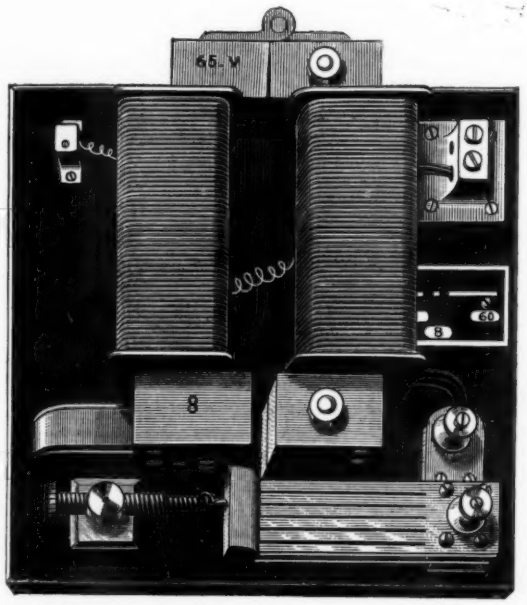
If the primary wire alone were encased by an iron sheathing, the lines of force from it would not pass outside of the iron casing; being retained by it, there would therefore be little or no induction in a secondary wire outside of the iron casing, even if quite near. This is made use of in some anti-induction wires, in which the wire which produces the induction is wound with iron tape or bands. This applies only to the primary or disturbing wire; a wire would not necessarily be protected from induction from others by being itself encased by iron; thus in the case of an electric light and a neighbouring telephone wire, it is the former and not the latter which should be encased in an iron sheathing.

C. H.

Ship Lighting.—We are informed that the London and Edinburgh Shipping Company has placed—through Messrs. Morton & Co., shipbuilders, Leith—another order for the lighting of its steamers by means of electricity with Messrs. Hine and Urquhart, Glasgow, who traded for many years as Henry Bennett & Co., the Scotch representatives of Messrs. Woodhouse and Rawson. The dynamo to be used is a D_2 S. Brush dynamo.

AN IMPROVED AUTOMATIC CUT-OUT.

A SIMPLE and successful form of automatic circuit closer and cut-out has recently been patented and introduced by Messrs. Elwell-Parker, Limited, of Wolverhampton, and is illustrated by the accompanying engraving, which we reproduce from *Industries*. It consists of a pair of opposed electro-magnets, one of which is fixed to the base board and the other hinged to the fixed magnet, so as to be capable of a small amount of angular motion. To the free pole-piece of the hinged magnet there is attached a contact-piece, which is capable of closing a circuit of which two contiguous brushes form part. This contact-piece is, when the apparatus is out of action, kept out of contact with the brushes by means of a spiral spring, the tension of which may be adjusted by a regulating screw. Referring to the engraving, the fixed electro-magnet is shown to the right; this is wound with cable or wire of sufficient thickness to carry the whole current of the circuit without heating. The hinged electro-magnet is wound with fine wire, which is in a shunt from the main circuit. The contact-piece, spring, regulating screw, and brushes are seen below the magnets. The circuits are so arranged that when the contact-piece is in metallic connection with the brushes the main circuit is closed. When the dynamo is first started the main



circuit is held open by the spring, but as a current at once commences to traverse the coils in the shunt circuit on the hinged magnet, this magnet is increasingly energised until finally it overcomes the pull of the spring and closes with the fixed magnet, contact with the brushes being made simultaneously. It follows, then, that from this instant current traverses the main circuit and the coils of both magnets; the contact, once made, is consequently firmly held so long as the current exists. The tension of the spring is regulated in such a manner that the main circuit is closed only upon the current reaching a predetermined E.M.F.

This apparatus is intended for use in connection with secondary batteries, and for this purpose it appears to be decidedly simpler than, and generally superior to, its predecessors. It will be evident that on an accidental cessation of the dynamo current, or in case the E.M.F. of the battery from any cause exceeds the E.M.F. of the dynamo, the battery will at once be automatically cut out. With its use failure of action or a reversal of polarity of the dynamo is practically impossible.

ON THE DISSOCIATION OF SOME GASES BY THE ELECTRIC SPARK.*

By J. J. THOMSON, M.A., F.R.S., Fellow of Trinity College, and Cavendish Professor of Experimental Physics in the University of Cambridge.

THE gases considered are iodine, bromine, chlorine, and nitrogen tetroxide. The effects of the spark on iodine and bromine were investigated in two ways. In the first method the iodine was placed in a tube from which the air had been exhausted, and which was furnished with a gauge which served to measure the changes of pressure in the tube. The liquid in the manometer was sulphuric acid, and in order to avoid any disturbance due to the absorption of the iodine vapour by this substance, the discharge tube was doubled so that the iodine vapour was symmetrically placed with reference to the sulphuric acid. The system was then placed in an oil bath and maintained at a temperature which varied in different experiments from about 200° to 230°.

On sparking through such a tube with an induction coil giving a spark about 3 inches long in air, the pressure rapidly increased at first, but the rate of increase gradually diminished and the pressure finally becomes steady. On stopping the coil by far the greater part of this increase is permanent, or at any rate lasts for several hours. It is not due to the decomposition of the vapour from the sulphuric acid in the gauge, for it does not occur if there is no iodine in the gauge, or if the iodine is replaced by bromine. This increase of pressure can be produced by the silent discharge as well as by ordinary sparking. In order to test this point more completely, I had an arrangement made by which instead of determining the increase of pressure by the sulphuric acid gauge, the vapour density of the iodine after sparking could be measured. In this arrangement the iodine was never near any sulphuric acid.

The result of these determinations is shown in the following table, and it is seen that the results confirm those obtained by the first method.

Pressure.	Temperature.	(H = 1) Vapour-density.
Unsparked iodine—		
440 ...	... 215 ...	... 137
420 ...	... 214 ...	... 130
Sparked iodine—		
618 ...	... 220 ...	... 110
420 ...	... 216 ...	... 115
166 ...	... 214 ...	... 84
170 ...	... 232 ...	... 86

In the last experiment the vapour-density was determined 24 hours after the sparking.

These figures point to very considerable dissociation of the iodine, in fact the dissociation produced by the spark at 214° is as much as that produced by Victor Meyer at the temperature 1570° C.

The appearance of the dissociated iodine is not greatly different from that of the unsparked, its colour, however, is I think a little lighter and not so uniform. I was not able to detect any change in the absorption spectrum produced by the sparking. The electric strength of the sparked gas was, however, less than that of the unsparked.

Bromine.

When the experiment with the pressure gauge is made with bromine instead of iodine, it is found that there is a considerable increase of pressure produced by the passage of the spark, but that this disappears almost as soon as the sparking, and on determining the vapour-density of the sparked and unsparked bromine it is found that they are identical. It seems most probable that the difference between bromine and iodine is not that the bromine is not dissociated by the spark, but that the atoms combine very much more quickly than the iodine atoms. The vapour-density determinations

* Abstract of the "Bakerian Lecture," delivered before the Royal Society.

showed that bromine vapour is dissociated if it is heated for a long time at a low pressure, even though the temperature is not very high.

The results of these determinations are given in the following table :—

Pressure.	Temperature.	Density.	Remarks.
473	111	80	
466	106	81	
430	101	80	
602	116	79	
543	89	81·7	In bath for 24 hours.
315·5	105	73	
235	109	77	*Sparked.*
230	100	66·5	In bath for 4 hours.
165	90	77	Only a short time in bath.
390	111	70	In bath for 7 hours.

These experiments show that it takes a long time for bromine to reach a state of equilibrium, and that for the experiments on the vapour-density, the gas should be kept for a long time at a constant temperature before the experiments are made.

Experiments on chlorine and nitrogen tetroxide are also described in the paper.

SALINE CRYSTALS OBTAINED BY ELECTROLYSIS.

By ALEXANDER WATT.

WHILE electrolysing a solution of nitrate of alumina, a few days since, some remarkable effects presented themselves upon the negative electrode which may be worth recording. In the first instance, a piece of stout copper wire was used for a cathode, and after a few moments' immersion, this became covered with bubbles of hydrogen of unusually large size, being about the size of No. 8 shot, while some were considerably larger. The gas had little disposition to leave the plate, even when briskly moved about in the bath. On removing the wire from the solution, after about two minutes' immersion, it was found to be coated with a transparent crystalline film, some of the crystals standing out from the copper surface, in the form of plates, to the height of about $\frac{1}{8}$ inch. The wire was now dipped into a test tube containing hot water, to ascertain whether the crystals were soluble or otherwise, when it was noticed that they were *insoluble*. Some of the crystals eventually dropped off and quickly deposited at the bottom of the tube, while the remainder retained their position. The copper wire was next taken out of the water, and the remaining salt upon its surface allowed to dry, in doing which it assumed an opaque white powdery character. Treated with dilute nitric acid, the powder became dissolved, and the solution, being afterwards treated with a solution of carbonate of soda, yielded a flocculent white precipitate. While the crystals referred to were forming upon the cathode, aluminium oxide was produced at the anode, from the surface of which electrode bubbles of oxygen were also given off. The conclusion I arrived at was that the crystalline substance deposited upon the cathode was *nitrite of aluminium*, but I shall be pleased to be set right if I am wrong in my hasty conjecture. The experiment was shortly after followed up by employing a strip of sheet copper for the cathode, and giving a longer immersion, when the crystalline deposit became more extensive, and the flat plates of the salt much larger. I have omitted to mention the fact that when the wire cathode was placed in hot water, bubbles of gas re-appeared upon its surface, and when the wire was briskly moved about in the liquid, the crystals thus displaced assumed a flocculent character, and, intermingled with globules of gas, remained floating in the liquid until it was cold, when the salt, still mixed with a few gas-bubbles, sank to the bottom of the test tube, where these retained the same position for many hours after. The salt was insoluble in boiling water.

ON THE "SILVERTOWN."

THE *Silvertown* is the finest cable ship afloat, and it was a happy thought, and a generous one, which occurred to her owners to fill her with visitors from stem to stern and take her around the coast to Spithead. The India Rubber, Gutta Percha, and Telegraph Works Company is nothing if not thorough in everything it undertakes, so that when the invitation of the directors reached us to join the ship at Greenhithe at 5 o'clock on Thursday evening last week we were prepared for thoroughly hospitable entertainment; but the splendid, almost prodigal, scale upon which every proceeding having relation to the comfort and enjoyment of the numerous visitors was planned and carried out, was a surprise even to us. The Naval Review, the massing of all the available strength of the finest navy in the world, of a navy in fact which outnumbers and outshines any other two or three, was an event not soon to pass from the recollection of a patriot; the magnificent illumination of the fleet at nightfall (to which a few words of description are given elsewhere in these pages) formed a spectacle unsurpassable for grandeur and weird beauty of effect; but our pleasantest memories of the unique occasion will ever and always be those associated with the trip itself and not with the object of it. Weather the most exquisite, water perfectly smooth, and the ship as steady as a rock, scenery of a kind delightful to the eyes of a jaded Londoner—an ever changing panorama of land and sea views—the swift and regular progression of the noble ship, and last and best of all a hearty, laughter-loving company, every member bent on enjoying to the full the pleasures of the cruise. These were the elements which in combination enabled us to spend some of the rarest of holiday hours, hours of pure and complete delight, in which the mind was free and the spirits were exalted beyond the possibility of suffering from the intrusion of the sources of care common in everyday life, and in which there was no room for any thought but that of giving and receiving pleasure—such hours and such days, in fine, as we do not expect soon again to enjoy. Steaming from Greenhithe, the night was spent in passing round the coast of Kent; in the early morning we were in the English Channel, where cool breezes blow freely on the warmest day. We then held a grand review of the charming South Coast watering places: Brighton, Hastings and Eastbourne were all in the garb which suits them best—they were clothed, that is to say, and superbly clothed, in the bright rays of the morning sun. Lest some should weary of parading the decks or gazing on sea and land, the hosts—and they were many, for all alike, from the directors, captain, and engineer-in-chief to the youngest member of the staff, were as assiduous as if every visitor was each one's particular guest—the hosts, then, arranged other means of providing interest. Mr. Rymer Jones endeavoured—strove very hard, in fact—to explain to the ladies the use of the mirror instrument, but he was at a great disadvantage, for they were quite sure they knew better how to use a mirror than he did; ultimately, he gave it up and passed on to the Wheatstone bridge, with which he was more successful; then he gave a demonstration of fault finding, at which his assistants agree he is *facile princeps*, and here, again, he had the undivided and earnest attention of the fair sex. Other operations which are peculiar to a cable ship's testing room, were shown, together with the mode of paying out cables; the fusion of lengths of iron wire by the electric lighting plant and the projection of the electric arc upon a screen were also demonstrated. These were all watched with interest, for to many, perhaps most, of the visitors they were new. In the evening music held beneficent sway. Lady Mance, Miss Preece, Miss Hutchins and Miss Gray, Messrs. Robert Gray, Matthew Gray, J. Rymer Jones, Sir Henry Mance, and others, contributed to the general enjoyment by capital renderings of various songs and ballads, and Mr. Blackwood played the queen of instruments, the violin, in a manner which was most appreciated by those of his audience who best understood the technical difficulties. His rendering of Gounod's "Ave Maria" will not soon fade from our memory.

An end to the downward voyage came on Friday afternoon, when we found ourselves in Southampton water. Here, early the following day, a large accession to the number of visitors was received, many having come down to Southampton by train from London and elsewhere. The ship moved out to Spithead for the Review on Saturday morning, and amongst those then on board were Mr. Abraham Scott, Mr. Gray, Mr. Robert Henderson, and the Hon. Henry Marsham, directors; Mr. R. Kaye Gray, engineer-in-chief; Mr. W. J. Tyler, secretary; Mr. G. Baden-Powell, M.P., C.M.G., Sir S. A. Blackwood, K.C.B., Sir Frederick Bramwell, F.R.S., Mr. J. Y. Buchanan, F.R.S., Colonel Cameron, R.A., C.B., Mr. G. von Chauvin, Captain Concas, R.S.N., Mr. H. G. Erichsen, Prof. Carey Foster, F.R.S., Prof. George Forbes, F.R.S., Sir Julian Goldsmid, Bart., M.P., Mr. E. Graves, Mr. Henniker Heaton, M.P., Mr. W. F. King, F.R.S.E., Sir Henry Mance, C.I.E., Mr. C. H. B. Patey, C.B., Mr. W. H. Preece, F.R.S., Sir Alexander Rendel, Mr. B. Silver, Major Alexander Wood, Mr. H. Trueman Wood, and others. Of the Review and the illuminations our readers may read as much as they will elsewhere. The weather was glorious, everybody was pleased, and the Review passed off in satisfactory style, but very quietly. The accidents which were attendant upon the assemblage

must be universally deplored, but little or nothing was known of these on board the *Silvertown* until long after their occurrence.

The *Silvertown* was not behind hand in the matter of illumination. To that the *Daily Telegraph* bears ample testimony. This is what that famous newspaper had to say respecting our vessel:—"The illuminations of the *Silvertown*, belonging to the India-Rubber, Gutta Percha and Telegraph Works Company, fairly rivalled those of the largest ironclad. In fact, her electric search light surpassed in brilliancy and power that of any other vessel, and as the operators "swept" every ship present, the crews of the other big mercantile steamers anchored near gave loud cheers of congratulation. The directors had invited a number of scientific men with many of the personal friends of directors and principal officers. In honour of the occasion the rigging of the immense ship was festooned with incandescent lamps, and these outlines of light proved remarkably effective."

Here we may suitably introduce a few particulars of the noble ship, which we extract from an admirable little *brochure* written by Mr. H. Benest and Mr. J. Rymer Jones. Her principal dimensions are:—Length, 350 feet; breadth, 55 feet; depth, 34 feet 6 inches; nett tonnage, 3,723 tons; gross tonnage, 4,935 tons; indicated horse-power, 1,800 tons. Her speed, when consuming 30 tons coal per diem, is at the rate of 11·0 knots an hour. The ballast tanks contain over 900 tons water. Size of cable tanks:—No. 1—fore, 46.′0 dia. × 30′ depth: No. 2—main, 53.′0 dia. × 30′ depth; No. 3—aft, 51.′0 dia. × 30′ depth. The total cubic capacity of tanks and cones is = 171,415 cubic feet. The contents of entire ship is = 500,000 cubic feet. On the Central and South American Expedition, 2,370 nautical miles of cable, weighing 4,881 tons, was coiled on board in 22 days; the greatest length coiled in 12 hours being 65 nautical miles, or nearly 6 nautical miles per hour. Two, and sometimes three, runs were kept going for days together, and this during an exceptionally cold and foggy month (February, 1882), when it was often impossible to see the lead barges, or even boats alongside, for entire days and nights. In addition to this enormous dead weight, 1,660 tons of coal, 111 tons of buoys, chains, gear-cable, office and telegraph fittings, and 159 tons of provisions and water were put on board at Gravesend. The total weight on board was 6,812 tons. Her draught was 27 feet forward and 29 feet 6 inches aft, the greatest draught of any merchant steamer, except the *Great Eastern*. Her mean draught is 28 feet when carrying 6,390 tons. She has bunker capacity for 1,300 tons of coal, besides which over a thousand tons can be carried in fore hold; this large quantity of fuel enables the ship to travel farther, and to remain a longer time at work without coaling, than any other existing telegraph steamer. For example, on the First West African Expedition, the *Silvertown* left the Thames on the 18th September, 1885. with 1,800 tons, and returned on 21st January, 1886, after an absence of over four months, with 610 tons of her original stock of coal. Besides this vessel the company own three other steamers—the *Dacia*, *International*, and *Buccaneer*—each specially fitted for cable and sounding work, and of the collective carrying capacity of 5,200 tons. To man these ships, and carry out the work required, 400 officers and men of all departments are employed.

The electric light plant on board the *Silvertown* consists of three small horizontal engines, each driving by belt a dynamo machine. One of the machines is used for the lighting, by incandescent lamps, of the saloons, cabins, cable-tanks, &c., the number of lamps fixed being about 80. The advantages obtained by using incandescent lamps have been very great, especially when cable-work has been done in hot climates, and also, as the lamps have no exposed flame, they can be used in places where oil lamps would be a continual source of danger and fire. The other dynamo machines are used to supply current to arc lamps, which can be fixed in any position desired on the ship, the cables for conveying the current from the dynamo to the lamp being uncoiled from drums and laid where required instead of being permanently fixed, as are all the conductors used for incandescent lighting. As it is often desirable to be able to see objects such as buoys, &c., at great distances, a search light plant has been fitted up which consists of an engine and dynamo machine capable of supplying current to a lamp of about 60,000 candle power. This lamp is fitted in a projector with horizontal and vertical traversing movements, and with it objects 3 or 4 miles distant, in any direction, can be rendered distinctly visible; whilst the light itself can be seen by observers at any distance as far as the visible horizon. When triangulating the Mediterranean shores, some few years ago, a light of this character was used. That set up on Muley Hassin or Malahacen, a peak of the Sierra Nevada, 11,830 feet above sea level, and about 20 miles inland of the south-east coast of Spain, was clearly visible from a similar station in Morocco, probably on Mount Anna, 7,220 feet high. The distance between these two points being 136 nautical miles.

The Review over and the illuminations at an end, the *Silvertown* returned to Southampton about midnight, placed the train-travelling visitors on shore, and early next morning started on the return trip to Greenhithe. Passing the Sussex watering places this time at night we found that a new spectacular joy awaited us, for the long lines of electrically-lighted sea fronts, with dotted back-grounds of twinkling gas lights, presented most attractive night pictures. The return was accomplished in safety and before disembarking the guests, cordial acknowledgment of the hospitality so gracefully dispensed were conveyed to the representatives of the Company by Sir Arthur Blackwood, who echoed the desire of everyone when he expressed the hope that some other jubilee would shortly come round, and that they might reassemble in honour of it upon the good ship *Silvertown*.

AMERICAN TELEPHONE PATENTS.

THE United States Circuit Court Room at Boston was crowded on June 13th, when arguments were heard on the defendants' demurrer to the plaintiff's bill in the celebrated case of The United States *v.* The Bell Telephone Company. Judges Colt and Nelson occupied the Bench. The defendants claimed that the plaintiff's bill was multifarious in that it joined allegations and prayers for relief in respect to patents Nos. 174,465 and 86,787. Mr. STORROW opened the case for the defendants, and reviewed the case at considerable length, occupying some three hours in his address.

Mr. C. P. LOWREY commenced his argument in the afternoon for the Government, but owing to the closeness of the atmosphere requested postponement until the next day. On the 14th Mr. LOWREY resumed his argument. He said that it was the plain duty of the Government to bring the suit. Both patents must stand or fall together. He claimed that the assignee company did not stand in any better position than the assignor. Bell, in regard to the sixth item of the demurrer, that the Bill did not set forth any fraud in the procuring of the patents; did not specifically set forth what acts the complainant relied upon; nor when, how, from whom, or by what means complainant first had knowledge of each alleged fact. Specific allegations of fraud were certainly made that it was not necessary to enumerate at this stage of the argument. Perjury was charged in the procuring of the first patent in 1876, and that specifically. For the second application in 1877, Mr. Bell was charged with surreptitiously procuring information of the items of another application, by Mr. Dolbear, in order to amend his own application. There was no lack of specification in that instance.

Mr. GOODE then proceeded to argue the right and power of the Government to prosecute and maintain the suit. He read the several divisions of the Bill separating the public and private rights in the premises. The United States claims its right to bring the suit. The demurrer admitted that misrepresentations had been made to Government officials: that the patents had been procured through these representations; that the patents were of great value and public utility; that vast sums were being received for their use: that no private parties had a right to bring suit against the patents; and that the Government was in a similar position. "Who is to prosecute a fraud if not the Government?" asked the counsel. "Are the doors of the Courts to be closed to the Government?" He held that the Government had a right to enter its own courts in equity to find cause to cancel a grant procured by fraud or made by inadvertence or mistake. When the king made a concession through false suggestion, he had the prerogative of cancellation on information. Several cases were cited in support of this view. In English common law suits of this description could be brought by any subject in the name of the sovereign with the approval of the law officers of the Crown. Where the public interest is at stake, the Attorney-General can always sue. Every state of the Union recognised the principle. Where the interest is merely private, the principle did not hold. In answer to Mr. Storrow that the Circuit Court had already settled the question at issue by a decision, Mr. Goode contended that the question then decided did not cover the ground sought to be covered here. There was no difference between patents for land and patents for inventions when fraud came in. That had been decided by the Supreme Court of the United States, and the principle was long recognised. Mr. Goode wanted the court to understand that it was entirely relieved of responsibility by the decisions already pronounced. The Commissioner of Patents could not revoke the issues of his predecessor. He was not a judicial officer. Such questions belonged to the courts. The cases upon which the defendant relies to maintain his demurrer were simply on private issues. The United States here attacks a grievous monopoly, of which the people were the victims from one end of the republic to the other, and it was charged that this monopoly was the result of patents obtained surreptitiously. The only congressional nullification of the power of courts to vacate patents was in 1836, when the courts were denied the prerogative when suits for cancellation were brought by private parties. The common law remedy always prevailed, and was never interfered with by any remedy that existed before that act. Mr. Storrow's claim that the Government had no common law rights Mr. Goode urgently combatted. How is it, he asked, that the Government had successfully instituted suits against lands when there were no statutory provisions in regard to them? The Government, of course, had property in the land. It was claimed that the Government had no property in an inventor's brain; but it did have a right to prescribe the validity and lease of that brain's product. It was the same right that it had to limit a soldier's bounty, whether in land or money, the settler's pre-empted grant, &c. The consideration was the bottom of it all, and if the consideration was falsely alleged, the contract was void, it was prejudicial to the public interest. It was absurd for the defendant to deny the United States the right to the cancellation of a patent by a court of equity on the ground of fraud proved. Fraud vitiated everything. There had been no laches, no delay on the part of the Government, and its case should be admitted. The Government was not a professed detective, roaming up and down the land. It always pre-

sumed sincerity of purpose until the contrary was made manifest. The validity of the patent was not attacked on any single allegation—the case rested upon the allegations as a whole. Mr. Goode closed his argument for the Government as follows: The time has not arrived to consider the issue on its merits. Much has been said by Mr. Storrow about previous litigation and the fact that the patents have been sustained by the lower courts. Those cases are now pending in the Supreme Court, but the Government is a stranger to them. There is no charge of fraud in those cases, which is the principal ground of action in this case.

Mr. CHAUNCEY SMITH, of counsel for the Bell Telephone Company, next spoke. The Bill, he said, is brought by one department of the Government to undo what had been done by another department of the Government. Something has been said about the inherent power of the Government to institute this proceeding. I don't understand what is meant by "inherent powers." The Executive must find its authorisation for its acts in the constitution or laws made under the constitution. Now, if the Government, or any one, from the President down, can't find his authority in the constitution, then he must find it in the law of Congress, for there is no other authority. But the Government in this case seeks to find its authority in the law of Great Britain. I deny that any such power can be found even in the statutes of that country. The power of the Crown to revoke an Act of Parliament does not exist. The power to bring an action of this sort is specially delegated to the officers of the Crown. It would not exist without such authorisation, and it is not claimed that any such authorisation has been made by Congress in this country. Mr. Smith argued further that no allegation was made by the Government which would not be an adequate defence for any infringer of the Bell patents, and therefore the extraordinary proceedings which had been resorted to was quite unnecessary. The Government sets up that it brings this complaint in order to reinstate the people of the United States in their rights. But an invalid patent deprives nobody of any rights. Such a patent may be infringed with impunity.

The court room was crowded when Judge THURMAN rose from his sofa and approached the counsel table to address the court. He said: My associates have argued this case so soundly, and it seems to me so conclusively, that anything I may say must be, to a certain extent, a repetition of their words. I have been urged as the dean of the faculty—by reason of years and not of learning—to address you briefly. The first and main question to be considered is as to the power of the Government to bring and to maintain this suit. The general power of the Government to bring such a suit is not denied, but the point the other side make is this, they maintain that this power cannot be executed without legislation by Congress to specify the officer and the mode by which the proceeding shall be set in motion. In the absence of such legislation they hold that the power is dormant and that the Government cannot use it. I don't deny that ingenious arguments can be made on the other side, but I maintain that it is not an open question and that it cannot be considered as an open question. Mr. Storrow claims that out of hundreds of thousands of patents issued only one has been set aside by such a proceeding as this. But of millions of land patents that have been granted hundreds have been set aside. There are very good reasons, only the Government has not been forward in bringing such suits as this—much stronger reasons than in the case of public lands. In most cases the defences raised by infringers of invalid patents are protection enough of the public interests. The Supreme Court has decided in the case of Whitney *v.* Mowry, that no individual can file a bill to set aside a patent; that only the Government could do that. Does anyone suppose that in the case of the Bell telephone that such bills would not have been filed long ago if individuals had the power to file them?

It is the duty of the executive to enforce the law. Mr. Smith argues that in that case it is the duty of the executive to proceed against infringers. That is ingenious, but I think if Mr. Smith will sleep on that proposition he will abandon it.

Mr. DICKERSON, of New York, for the company, followed, combating the idea of the competence of the Attorney-General to bring the suit. A bill that had been prepared by the Bell Telephone lawyers giving him that power in certain cases had been defeated. This was intended to compel a patentee to try his case, and not continue a doubtful patent in force. Every court in America and Europe, where the patent has been considered, had decided that Prof. Bell was the original inventor, but he had been subjected to such a fire of Billingsgate and vituperation as no man had ever sustained before. The whole matter with the complainants was the assertion that the American Executive was the successor here of the British King in a royal prerogative. They wanted just enough of English law entered into in this case to suit them—no more. Where was the rest of it? Spilled over from the Mayflower? The fact was, the power lay only in Congress—the people—and Congress had refused to act. The theory that the President was heir-at-law to the king was rather a peculiar view for such a good democrat as Senator Thurman to take. The Attorney-General, it was well known, had been turned out of the Circuit Court in a patent case, and was now in the Supreme Court on appeal. This patent had survived the most malignant litigation ever known throughout the length and breadth of the country, and now this court was asked to pursue it to its death. Mr. Dickerson contended that every allegation of fraud in the bill came under the criminal statute.

The Court took the case for decision.

NOTES.

The Electric Light at Weston-Super-Mare.—The recent opposition to the development of electric lighting in retrogade Bath has not been an unmixed evil, for it has served to arouse a spirit of enterprise among the inhabitants of Weston-super-Mare. A meeting has been held, at which it was resolved to endeavour to obtain the use of the electrical apparatus lately at work in Bath, and to arrange a deputation with Mr. Massingham, managing director of the Taunton Electric Lighting Company. As a result of the negotiations, permission has been obtained from the Local Board for the erection of the necessary wires and posts, so that the town may be experimentally lighted by electricity from the middle of August to the corresponding period in September. Six lamps will be placed on the Esplanade, which is the fashionable resort in the evening, and others will be distributed over the town. The sum of £150 has been promised towards defraying the expenses.

Electric Lighting in Tunstall.—Two of the streets of Tunstall are to experimentally lighted with the electric light.

The Electric Light at Leamington.—There seems likely to be some little bother at Leamington over the experiments of Mr. Arthur Chamberlain and his electric lighting company, who have been given *carte blanche*, apparently by the Town Council. The townspeople and the local newspapers have found this fact out, and are indignant that there is no contract or agreement under which, if the experiments do not result satisfactorily, Mr. Chamberlain will be compelled to remove his conduits and put the roadways in proper repair again. We await the development of the dispute with interest.

Electric Lighting in Cotton Mills.—A very complete system of electric lighting has been fitted up throughout the large new mills just erected at Bury by the Peel Spinning Company. The installation, which comprises some 500 lamps of the Weston type with wavy filaments, has been carried out by the Maxim-Weston Company through its local agent. The necessary current is obtained from two shunt-wound Weston dynamos, one of which is driven by a separate horizontal engine of 25 I.H.P., and the other by means of a countershaft and rope pulley from the large mill engines. Each machine supplies current for some 250 lamps, the whole number being alternated as usual; so that in case of any accident occurring to one dynamo, the other is still able to sustain sufficient lamps for carrying on the ordinary mill work. The engine power is divided in the same way to attain this end.

Street Lighting in Belgium.—An experimental installation of 500 C.P. arc lamps has been erected in the streets of Liège, the current from each being provided by a small combined dynamo and motor placed in the pedestal of the lamp-post.

Woodhouse & Rawson, Limited.—Since going to press with that portion of the REVIEW in which we have commented upon the new Woodhouse & Rawson Company, we have been informed that the patents which have been valued includes some important inventions other than electrical ones. We desire, therefore, to withdraw our remarks touching the value set upon these by the expert mentioned in the prospectus, for upon consideration of additional information now at our command, we think the sum named is under-estimated rather than otherwise. In any case, as we have said elsewhere, it is not of much importance, as the vendors take nothing for these patents except a share of the profits when over 10 per cent. is paid.

The Lighting of the Brussels Theatres.—This question continues to occupy the public mind. The College of Sheriffs has decided to interdict the re-opening of the theatre Galeries Saint-Hubert, on account of the danger of fire. On the other hand, the Commission of Theatres, after inspecting the theatres Vaudeville, Parc, and Eden, has pronounced them essentially safe. This commission, it may be noted, contains several persons interested in gas, and not a single electrician! It is further stated that the Alhambra Theatre in the same town is to be electrically lighted.

Electric Lighting in the Theatres of Berlin.—The Opera of Berlin is just closed, and the necessary works have been begun for extending the electric lighting. The performers' boxes and the concert hall are already lighted electrically, and the installation is now to be extended to the stage, the auditorium, and the corridors. The Edison Company has undertaken the complete suppression of gas in the establishment. The proprietors of the "Residenz Theatre," at Berlin, are in treaty with the same company for the installation of the electric light in the entire theatre before the commencement of the next season.

Central Station Electric Lighting in Vienna.—As already reported, the conditions which the Municipality of Vienna tried to impose upon Messrs. Siemens and Halske, with regard to the projected electric light station at Neubad, were so severe that the firm refused to entertain the project. They have now, *Industries* states, submitted a revised set of conditions to the Municipality on the following basis:—(1) The concession to be for 50 years; (2) The contractors to pay 3 per cent. of their gross receipts to the Municipality, but this not to include money received for sale or hire of lamps, fittings, and meters; (3) The contractors have the option within two years of erecting a second central station in the Blutgasse under the same conditions as the first station; (4) The consumers are required to pay a fixed charge of 15 florins for being connected to the mains, and a further charge in proportion to the number of lamps installed; in addition to these payments they will have to pay for current at the following rate per lamp hour: 2 kreutzer (·39 pence) for 10 candles, 3 kreutzer (·58 pence) for 16 candles, 6 kreutzer (1·16 pence) for 32 candles, 9 kreutzer (1·74 pence) for 50 candles, and 19 kreutzer (3·7 pence) for 100 candles—large consumers will obtain a discount; (5) The rental for the meters will be as follows:—for 160 candles 16s., for 320 candles 24s., for 500 candles 32s., and for 1,000 candles 40s. per annum.

Trunk-Line Extensions.—The National Telephone Company has in contemplation the erection of trunk lines between the West Riding of Yorkshire and Nottingham, Leicester, Birmingham, the Staffordshire pottery towns, and the Buxton district. Payment for the use of these trunk wires will be by fee at the time of using, and if a certain number of calls be guaranteed for the first year the erection of the lines will be proceeded with.

The Drumont-Deprez Litigation.—The Chamber of Correctional Appeals has confirmed the judgment which interdicted M. Drumont from calling evidence to attest the truth of the charges which he has brought against M. Marcel Deprez in his recently published book.

Telephoning in the River Plate.—Here is an item from an American paper which will interest a few telephone shareholders in this country:—The directors of the late United Telephone Company of the River Plate, now merged into the United River Plate Telephone Company, have handsomely manifested their appreciation of their manager, Mr. Adolph Fels, in a beautiful service of solid silver. The service consists of a pitcher, three drinking cups, and salver, in exquisite workmanship, the former bearing an appropriate inscription. Mr. Fels is the manager of the new amalgamated Buenos Ayres company, the largest telephone company in South America.

Shocking an Elephant.—An elephant, which forms a part of the "pageant of victory" in the play "Fall of Babylon," which is running at one of the New York theatres, recently met with a curious misfortune. Just as he was about to go on the stage the company was startled with a tremendous roar and the great elephant fell to the stage writhing in pain. It was discovered that he had been engaged in scientific investigations and had seized an electric light wire with his trunk. He received a severe shock, and his trunk was considerably burned, but he was not otherwise injured.

The Medal Fever.—Under this heading the *Echo* recently contained the following rather ungenerous remarks:—"The failure of the Society of Arts to obtain entries in its proposed 'trials of motors for electric lighting' may be due to a doubt whether much kudos or 'money' is to be found in the production of a suitable engine; but those who are behind the scenes know that the 'medal' business is about played out. The Society of Arts offered medals, and it has recently renewed the offer to all who will enter before the close of the present year; but the firms who do make really good engines are not likely to rise to the bait—a gold, or perhaps a silver medal—for the simple reason that there is no difficulty in making good steam engines now-a-days, but there is a great obstacle in the way of introducing them specially for electric lighting. If the Society of Arts had offered a handsome prize for the discovery of some means of making the electric light as cheap as gas, there would have been some sense in the offer; but a mere medal for the best motor is not tempting enough. The motors will be forthcoming directly the electricians can create the demand, whether 'medals' are to be gained or not; for we may trust the electricians to find out the best motors when they are ready with their part of the business."

The President and the Telephone.—The contract for the use of the telephones in the White House at Washington and in the Government offices expired on the 1st inst., and President Cleveland, after consulting with members of his Cabinet, has decided not to renew the contract unless at a reduced rate. The present rate is $100 a year for each telephone. Letters have been addressed to the telephone company from the heads of the several departments stating that they would order the telephones out of the departments unless the company reduced the price to $80 a year. An officer of the telephone company said that they had no idea of reducing the rate to the Government, and would prefer to have their telephones removed rather than do so.

How to Form a Primary Battery Company.—Organise under the laws of the State of Maine; 10,000 shares of stock, par value, $100 per share. Offer to let in your friends on the ground floor at $1 per share. Print some circulars, setting forth the millions (not) made in primary batteries in times gone by; explain indefinitely that a new discovery has been made of an (old) chemical by the aid of which current can be produced for domestic incandescent lighting. There are as gullible investors as ever were caught, and they will bite. Delays are convenient—carbons not ready, cups too porous. Keep this up as long as possible, and then get some batteries and run one or two incandescent lights far above their candle-power. Don't let them burn but a few moments at a time, and a 5 candle-power run up to 25 candle-power will last some days. Comment on the whiteness and steadiness of the light. When people apply for batteries, convince them of their folly, and induce them to purchase stock. When the enthusiasm is at its height, sell the stock, and be conveniently called to some other section of the world for a year. On returning, repeat the same operation.—*New York Electrical Review.*

P. & O. Steamers at the Review.—Amongst the electric illuminations at the Spithead Review there was probably nothing more effective than that on board the P. & O. Company's steamers *Victoria* and *Rome*. These were the only vessels in the fleet which carried a powerful arc lamp at each masthead, in addition to the usual rainbow of small lights; and both ships showed powerful search lights of the type used by the P. & O. Company, during the past 18 months for the navigation of the Suez Canal. The funnels of both ships also displayed the letters V. R. of mammoth size (upwards of 22 feet high). We may mention that the *Victoria*, which is the most recent addition to the P. & O. fleet, possesses a specially interesting electric installation, her dynamos being driven direct from ordinary Tangye compound engines at the low speed of 200 revolutions per minute; and the duplication of plant is so liberal in her case that one dynamo is able to maintain the whole of the 450 lamps on board the ship at full candle power. This installation has been carried out by the Anglo-American Brush Company under the superision of Mr. Hall, A.M.I.C.E., the electrical adviser to the P. & O. S. N. Co., and we hope shortly to give a full description of its details, which present many points of interest.

Electricity in New Zealand.—There seems to be no lack of electrical work for the very few people engaged in it in New Zealand. Mr. Walter Prince, of Dunedin, informs us that he has recently installed the electric light in the house of the Bishop of Dunedin, water-power being available for the purpose, and in the mills of the Timaru Milling Company, where steam power is used. At the time of writing (June 15th) he was expecting next day to test under actual working conditions a 10-15 H.P. transmission of power plant just received from Mr. Immisch, and which was to be employed in tunnel-driving work. The Reefton Electrical Transmission of Power and Lighting Company, which we have before mentioned, is expecting to be at work in another month. Mr. Prince had just received a 500-lamp plant from this company when he wrote. News of progress for the England of the Pacific is very pleasant, and we hope our friends in that distant country will keep us well supplied with information of what goes on there.

Rival "Medical Electricians." — At Marlborough Street Police Court on Saturday, the Medical Electric Belt, Truss, and Health Appliance Company, Limited, of New Bond Street, was summoned by C. B. Harness for having on July 11th, without the authority of Her Majesty or any of the Royal Family, or any Government Department, used in connection with their business the Royal Arms in such a manner as to lead persons to believe that they carried on business under such authority. Cornelius Bennett Harness, of 52, Oxford Street, deposed that he was the managing director of the Medical Battery Company. He was the patentee of several electric belts and batteries, and formerly two men named St. Clair and Wood had been in the employ of the company. They had, however, left, and it was alleged by the prosecution that they had started a business in Bond Street exactly similar to that of the complainant company, unlawfully affixing the Royal Arms on the premises without having the necessary authority. For the defence it was urged that before the defendant company took the premises in Bond Street the Royal Arms were affixed across the portico, and they had no right to remove them as they were the property of the superior landlord. The case, which occupied the Court for a considerable time, was ultimately adjourned for a week.

Business Notifications. — We are requested to announce that the business of manufacturing electricians hitherto carried on by Messrs. Bartrum, Pretyman, and Mumford has been transferred to Messrs. Bailey & Co., of the Fulham Potteries, who being makers of porous and stone ware will no doubt find the combination of the two businesses advantageous.

Gallant Rescues by Electricians.—The *Daily Mail*, of Waterford, of the 19th, contains an acccount of two gallant rescues from drowning in the Bay of Waterford. Mr. Pope, who is at present residing in Waterford as the electrician of the firm of Messrs. Laing, Wharton, & Down, who are putting up the electric light in the city, went with his colleague, Mr. Bate, the engineer of the firm, for his customary bathe on Tuesday morning, the 14th. After having been in the water on the right side of the Bay for a quarter of an hour, he heard loud shouting from Mr. Bate, who was on the left. Fearing that he was in difficulties, he swam towards him as fast as the heavy breakers of a somewhat rough morning would allow, and found him striving to reach a man who, already unconscious, had drifted into the current. Mr. Pope now rushed into the current after the drowning man, and after drifting for some distance succeeded in reaching him, and after an exhausting struggle with the heavy seas for about ten minutes he got into his depth and transferred his burden to three or four men who came forward for the purpose. The man, after the use of the customary restoratives, recovered. Mr. Pope, on reaching his box, found himself completely exhausted and unable to stand. While Mr. Bate was attending to the wants of his colleague, another cry was heard, and a little investigation showed that a priest—Father Dooley—becoming exhausted in the effort to bring in a half-drowned man had been obliged to let him go. On this, Mr. Bate seized a life-buoy and, followed by Mr. Phelan, a grocer in the city, succeeded in reaching and rescuing the man. The person saved by Mr. Pope was Mr. Denis Keogh, a medical student; the one who is so much indebted to Mr. Bate is Mr. O'Farrel, a ship-broker. We have much pleasure in being able to chronicle such doughty deeds, and we hope that the Royal Humane Society will not be slow to recognise such gallant conduct.

"Tyndall on Heat."—Professor Tyndall enjoys a reputation similar to that of the late Earl of Beaconsfield for inventing nicely turned phrases. Writing from Switzerland he remarks that "Liberal England and Liberal Scotland are fouled in the meshes of one perverted intellect," the perverted intellect referred to being, of course, that of the G.O.M. In his letter which contains more matter of the same kind, we have "Tyndall's Sound," "Tyndall's Heat," and the professor would have us believe "Tyndall's Light." Why he should allow the deep azure of the alpine skies which he so loves to be clouded by the darkness of political strife we know not, but surely he has not taught the world all he can about the motions of the glacier. On the latter subject he is an authority, on politics he is not.

Reckenzaun's Electrical Tramcars.—We learn that a car is being fitted up in Philadelphia with Reckenzaun's motors and gearing in exactly the same manner as that in Berlin. Messrs. Stephens, Smith & Co., of Millwall, will, we understand, construct the motors.

Southport Winter Gardens.—The electric light is to used for illuminating at night the switch-back railway, which has just been constructed in these gardens.

Electrical Athletes.—At the electric lighting department sports of the Manchester Jubilee Exhibition, which took place on the 26th inst., a tug-of-war contest was arranged between representatives of the Brush and Edison Companies, and was won by the latter. We are not informed whether the brush was a severe one.

The Telegraph Jubilee Dinner.—It does not seem to be generally understood that the large lithographed design which was posted to all those attending the dinner is intended by the committee to serve as a *souvenir* of the occasion. One gentleman wanted to know if it represented the title page of a new publication, and others referred to it in any sense but the right one. We may add that additional copies may be purchased from Messrs. Brand & Co., lithographers, of New Street, Cloth Fair, E.C.

Croydon and its Gasworks.—The recent unsuccessful attempt of the Croydon Town Council to induce the ratepayers to sanction the purchase of the Croydon Commerical Gas Company led to the expenditure of £774 15s. 7d. We should think the ratepayers will have a few strong words to say to the council when this bill comes to be paid. That such an expenditure was necessary for placing before the inhabitants of the borough a scheme of which they did not approve, few will believe, and it is a pity that those members who were instrumental in incurring it cannot be called upon to contribute some considerable proportion of the money out of their own pockets.

Munro and Jamieson's Electrical Pocket Book.—We are glad to learn that the 5th edition of the electrician's *vade mecum* has been called for. As it is directly to the interest of all connected in electrical matters that a handy book such as this should be absolutely free from mistakes, and should contain the most useful and recent data likely to be referred to by practical electrical engineers in as concise and easily understood a form as possible, we would suggest that any improvements, additions, or erasions which occur to our readers should be drawn attention to through our pages or addressed to the authors. Of course such a pocket book is not meant to contain matter so fully, neither can it compete with Kempe's "Book of Practical Testing," and such like treatises, but it has its useful sphere both in the laboratory and the factory, just in the same way that Molesworth's has for mechanical and civil engineers. Every one, therefore, who assists in making it perfect is benefitting the profession.

Personal.—Major-General Webber, C.B., R.E., has resigned the position of managing director of the Anglo-American Brush Electric Light Corporation, Limited, and has accepted the appointment of consulting technical adviser to the Corporation. Mr. E. Garcke has been appointed manager and secretary.

Institute of Mechanical Engineers.—The summer meeting of the Institution of Mechanical Engineers is to be held in Edinburgh on Tuesday and Wednesday next week. Mr. E. H. Carbutt will be the president. Mr. David A. Stevenson, of Edinburgh, will read a paper describing the electric light on the Isle of May Lighthouse; Mr. Frederick John Rowan, of Glasgow, one on "Electro-magnetic Machine Tools;" and Mr. William Geipel, of Edinburgh, one on "The Position and Prospects of Electricity as Applied to Engineering."

Electrical Balloon Signalling.—On Monday evening Mr. Eric Stuart Bruce exhibited at the Kensington Town Hall a set of signalling apparatus, which he is supplying to the Belgian Government, by whom experiments are about to be made under Mr. Bruce's personal superintendence. The balloon is 15 feet in diameter with a gas capacity of 2,000 cubic feet, and is made as portable as possible. It is made of cambric, varnished, an extremely light material and far less costly than silk. The lamps for the interior of the balloon are fixed on a kind of ladder, six lamps being attached to as many cross pieces. The lamps are Edison and Swan 8 to 10 candle-power, 24 to 25 volts. A new arrangement was also shown for suspending lamps outside the balloon instead of inside, consisting of a sphere from which project lamps at various angles. The lamps are protected from breakage by a wire cage. This piece of apparatus is useful under certain atmospherical conditions. An E.P.S. storage battery of 25 cells is used as the source of electric power. The cells are of the 11 S type and the boxes which enclose the plates are of teak. Twin flexible insulated electric cable, as made to Mr. Bruce's specification, was also shown, in which lightness, strength, durability, and current capacity are combined. In the signalling key and switchboard there are special improvements of detail on the earlier pattern. In the former there are carbon contacts instead of platinum. These carbon contacts when worn away by use and sparking can be easily renewed at trifling expense.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

United Telephone Company of Rosario, Limited.—The Registrar of Joint Stock Companies has been requested by the signatories to this company to take the name of the company off the register, as the company has not done, nor does it intend to do any business, and no liabilities have been incurred. The registered office of the company is 61, Moorgate Street.

Dollond Electric Ships' Log Company, Limited.—The return of this company made up to February 15th, 1886, was filed on the 25th inst. The nominal capital is £15,000 in £5 shares, but only seven shares have been subscribed for, and upon these no call has been made. Registered office, 1, Ludgate Hill, E.C.

Northern District Telephone Company, Limited.—At the fifth ordinary general meeting of this company held on the 13th ult. at Arcade Chambers, Sunderland, the following resolution was passed:—"That the following addition be made to clause 63 of the Articles of Association, viz.: 'Four of whom shall be nominated by the United Telephone Company, Limited,' and these four shall be *ex officio* members of all committees of the board. Also that clause 64 be varied by omitting therefrom the words, 'he shall have held his qualification for at least three months next preceding the date of his election, and.'" This resolution was confirmed 7th inst. and registered 21st inst.

Chatham, Rochester, and District Electric Lighting Company, Limited.—The registered office of this company is at 22, High Street, Chatham.

CITY NOTES, REPORTS, MEETINGS, &c.

Anglo-American Telegraph Company, Limited.

THE ordinary general half-yearly meeting of the proprietors of this company was held in the Great Hall of Winchester House, City, on Wednesday. The Chairman of the board of directors, Viscount Monck, presided, and there were also a good number of shareholders present. The report, which we published last week, recommended a quarterly interim dividend of five shillings per cent. on the ordinary stock and ten shillings per cent. on the preferred stock.

The Chairman, in moving the adoption of the report, said that during the past half year they had carried a very large volume of traffic, and had done it most efficiently, but he was sorry to say that when interpreted into £ s. d. it was not quite so satisfactory. They had, however, this satisfaction to be derived from the fact, that the pecuniary condition of the other companies, their rivals, was not a happy one either. Therefore it seemed that the hardships they were suffering were rather in the nature of things than the result of any deficiency in the management of the company. He would not attempt to give them any figures showing the increase of the traffic as compared with former periods for several reasons. If they compared it with the corresponding period of last year they would find that they were not then carrying on their traffic at the same rate, and therefore a comparison would be entirely fallacious and misleading. In the next place their experience was that the second half of the year was a good deal more productive than the first half, and that would also vitiate a comparison. There was also another thing not to be neglected, namely, the withdrawal of the French Company from the "pool"—the right of which withdrawal they, of course, disputed. He should simply content himself with saying that the sixpenny traffic had brought a very large and substantial increase during the time it had been in operation. With regard to their plant he might tell them that the whole system was in excellent condition with one single exception, namely, the Brest-St. Pierre cable. That cable was the oldest Atlantic cable in existence which was still working, or rather working up to the time it broke. The break had taken place in the spring time, and perhaps some observations might be made because it had not been repaired sooner; but gentlemen who were acquainted with cable

work in the Atlantic would know that it would have been absurd at that period of the year to have sent out an expedition to repair it. If they looked at the accounts they would see that they had earned a matter of about £6,000 by the hire of the ship in the meantime. With regard to the future he confessed that he had very little to tell them. They had all probably seen reports in the New York papers with regard to discussions for the arrangement of the difficulties between the companies. All he could say was this: They were aware of the proverbial connection between fire and smoke, and through that he was led to believe that such communication might have taken place; but so far as their company was concerned, or their sister companies, they had had no proposition laid before them with which they could deal. Consequently, so far as they were concerned, they were precisely in the same position, with regard to the competition for traffic, as they were when he last addressed them. He had told them last year that the policy of reduced rates would, so far as he could see, in the long run be successful, and that it would stimulate the traffic. Well, the traffic had been stimulated, had very largely increased, and was increasing; but it had not yet reached a point at which they could pay anything like a satisfactory dividend. They were very much in the hands of others with reference to any change in their policy. This was a matter upon which he did not want to dogmatise, or to lay a hard-and-fast line, or to use any expression which would interfere with any arrangement which might be considered advisable for the companies to adopt. He told them last year that they recommended a sixpenny rate, not because they preferred it, but because it was a low rate which would have the effect of stimulating the traffic. He still held that opinion, and he had a confident conviction that if by any arrangement they were to raise the rate up to a large figure, they would infallibly have increased competition. He believed the directors' experience had led them to the conclusion that such a proposition would be higly inexpedient. His own conviction was that they ought to go on; he did not say at sixpence, a shilling, or any other figure, but they ought to fix it at a low rate in the hope of stimulating the traffic, and thereby making a livelihood for themselves. He asked them to give the directors their full confidence, because they were doing all they could, and endeavouring to economise in every way; and they hoped that the continuance of their policy would enable them to pay, if not a large, at any rate a satisfactory dividend.

The Marquis of Tweeddale seconded the motion.

Mr. Smith (York) thought that the traffic receipts were highly satisfactory and very encouraging. To his mind they showed that the sixpenny rate was an increasing success. He considered that the directors had nothing to do but to sit still and work on. In fact, it showed that the future policy must be worked upon this tariff. Probably they would have to suffer from the want of dividends, but he was quite willing to forego his if the directors would be anything like fair and divide with them. He thought that they ought to have had more consideration from the shareholders and have declared a dividend of ten shillings per cent. on the ordinary stock and twenty shillings on the preferred stock. This would have left £823 6s. 8d. to be carried forward. It was a serious matter when they carried forward a balance to next year's account of 50 per cent. of their net earnings. He had been a shareholder for 20 years and he had not known of such an act as this. Indeed, it was preposterous. Were they short of credit at their banker's, or did they require further security? Why, they had £84,696 uninvested! With this at their bankers he thought that there was no necessity for paying such a small dividend. What did the shareholders suppose this £84,000 represented? So far as the report went it showed that the bankers allowed them the munificent sum of £165 8s. If it had been invested at 3 per cent. it would have produced £1,200 for that time. He wished that they would take a lesson from the Globe company and draw out their accounts in the same way. So far as the present schedule went it merely showed that the securities altogether cost nearly a million of money. He would, moreover, like to know the meaning of the expense of the head office in London which had cost £630 more than last year? Perhaps they had had extra clerks?

The Secretary (Mr. T. H. Wells) replied that they had had extra clerks, and that the traffic had been double that of the last half year.

Mr. Smith, in conclusion, moved "That the report be adopted with the exception of the part of paragraph 3, which stated that £18,323 6s. 8d. be carried forward to next account; and in lieu thereof that a dividend of ten shillings per cent. be paid on the ordinary stock and twenty shillings on the preferred stock, leaving £823 6s. 8d. to be carried forward."

Mr. C. E. Davison seconded the amendment.

The Chairman, interposing, said he was precluded from putting Mr. Smith's amendment to the meeting by the articles of association. The shareholders were precluded by these articles from declaring any larger dividend than that decided upon, or advised, or recommended, by the directors. He felt the greatest possible sympathy with the shareholders who for so many years had treated the board with so much confidence and forbearance, but he could not violate the articles of association. The fact was, this was an interim dividend. They retained this fund in their hands, and would distribute it in the course of the next six months. At the moment they had a very expensive repairing expedition going out, and they might require money for it.

Mr. Abbott, Mr. Griffith, Mr. Newton, Mr. Herbert Smith (London), and Mr. Humphries, having spoken,

The Chairman thought Mr. Humphries took rather a prejudiced view of the board, because he said that the adoption of the 6d. rate was an act of temper. Now he could say that so far from its being an act of temper it was carefully considered, and that the decision was only arrived at after weighty deliberation. Mr. Smith had animadverted on the amount of the dividend, and had recommended that the board should declare a 10s. dividend. Now that balance was only an estimated balance. The dividend was only an interim dividend, and they would, he hoped, receive another and a larger dividend.

A Shareholder: You told us that six months ago.

The Chairman, continuing, said he did not pretend to be infallible, but so far as the estimate was concerned they had the money in their hands. Mr. Smith and other gentlemen had made some observations about the uninvested balance of the reserve fund That balance was a sum which was, partly, not yet paid. Another portion of it was a sum which they would have to pay in the course of a few days for the expenses of the repairs. He put it to them, he put it to Mr. Abbott, did they, or (he), think that it would be a wise thing for them to incur the cost of the brokerage? (A Voice: Must pay the brokerage.) They had sent out 300 miles of cable that had to be paid for, and it was to save the money of the company that they did not propose to invest the small sum of £13,000, which had been made a good deal of.

Mr. Smith: I could not make more than £13,000 of it.

The Chairman, resuming, said this £13,000 included small sums which had been invested. If Mr. Smith desired to see the books he could.

Mr. Smith said he wanted the particulars for the benefit of the shareholders. He could not bring a body of shareholders to the office.

The Chairman, continuing, said that, in reply to Mr. Abbot's inquiry, he might say that the stocks were worth £25,000 more than the original cost. With regard to the revenue from the renewal fund, that question was a subject of arrangement entered into between the directors and a committee headed by Mr. Smith. The result of that arrangement was that no further addition should be made to the fund, except the interest derived from its investment. As to the revenue from the reserve fund, he could only say that they would consider when they got it how it should be disposed of to the best interests of the shareholders. They intended, whenever the accounts were rectified and arranged, to give the balance of £18,000 to the shareholders. He was sorry that he had had to reject Mr. Smith's amendment, but he could not consistently put it to the meeting.

Mr. Smith: Would your lordship allow me to put it to test the feeling of the meeting?

Voices: "Withdraw," and "No."

Mr. Smith afterwards withdrew his amendment, and expressed the hope that the accounts would be made out in the future in the same way as those of the Globe Company. He should also like to know what stocks they sold and what they bought. In fact, he thought the shareholders had a right to insist that they should know.

The Chairman: What you want is a detailed account of the cost of every investment?

Mr. Smith: Just so; and carried out every half-year.

The Chairman thought that he had met Mr. Smith's wishes by stating what those investments were worth now.

The report was afterwards adopted.

On the motion of Mr. Abbott, seconded by Mr. Smith, a vote of thanks was unanimously accorded to the directors. The chairman responded, and the meeting ended.

Submarine Telegraph Company, Limited.

THE half-yearly meeting of the proprietors of this company was held at the offices, 2, Throgmorton Avenue, London Wall, on Monday, Sir Julian Goldsmid, Bart., M.P., presiding.

Mr. S. M. Clare having read the notice convening the meeting, the following report was taken as read:—

"The accounts for the six months ending 30th June, 1887, show a result which enables the directors to add the usual proportion of the receipts to the reserve fund, and to recommend a dividend at the rate of 12 per cent. per annum, and to carry over a balance of £979 5s. 1d. to the next account. The dividend for the corresponding period of 1886 was at the rate of 12 per cent. per annum also, and the balance carried over was £523 5s. 7d. The average length of the messages transmitted in the half year has been 11·06 words, against 11·05 in the corresponding six months of 1886, but there has been an increase of 135,427 messages in 1887 compared with 1886. The total working expenses for the half year of 1887 show an increase of £1,005 13s. This increase is accounted for chiefly under the heads of 'salaries and wages,' 'repairs to premises,' and 'repairs and insurance of steamer.' The number of accidents to the cables in the two half years has been about the same. All the company's cables, as well as those worked by the company, are in good working order."

The Chairman, in moving the adoption of the report, said it would be observed that there had been a fair increase of traffic, but he did not consider that that increase was altogether normal. He had several reasons for that opinion. First, there was an enormous increase in the number of messages, owing to the earthquake in the Riviera last winter; shortly afterwards there was an alarm of war between France and Germany, which caused

a tremendous amount of telegraphing between continental countries and England; and then there was also a large temporary increase in consequence of the vast number of august visitors who came to this country in honour of the jubilee. He regretted therefore to say that the increase of traffic, satisfactory as far as it went, did not appear to be of a permanent character. Practically they appeared, for the present, to have come to an end to the fall in the number of words comprised in each message. On the whole he did not consider that the position was unsatisfactory, because, if they had come to an end in the fall of words per message, he believed there must before long be a natural and steady increase in the business of the company as in the business of the world generally. The less he said regarding the future of the company the better, because they had a year and a half, or rather more, to exist under the present conditions, and what the conditions would be after the expiration of that period he was not in a position to state. The shareholders would have observed that questions had been asked of the Postmaster General in the House of Commons as to his wishes with regard to the contract. Similar questions had been asked in the French Chamber, but both ministers had observed a fair and due reserve, replying that the matter was occupying their attention. Acting as the shareholders' minister, it was his (the chairman's) duty to put the matter before them in exactly the same light; that was to say, the directors would do all they could to maintain the interests of the company. But they must ask for a renewal of that confidence which had always hitherto been reposed in them. Mr. Robert Bourke—who was now Lord Connemara—left the board when appointed to the high office of Governor of Madras. At one time he was in hopes that they might have filled his place was a most illustrious man, whose name he was not at liberty to mention, but in this he had been disappointed. He was glad to think, however, that they had obtained an able, active and intelligent gentleman, whose name would be submitted to the meeting. This was the Hon. J. S. Gathorne Hardy, M.P., son of Lord Cranbrook; he was an experienced business man, and capable of giving them valuable assistance. There was nothing special in the present condition of affairs; he thought they would probably have a quiet and normal half-year, and that at the end of it he would have to report, certainly ot a large increase, it any increase at all. Their property was in good order, they were doing their best to satisfy the public, in whose interests they worked as well as in the interests of shareholders. He moved the adoption of the report.

The Hon. Ashley Ponsonby seconded the motion.

A Shareholder asked upon what basis the proportions of the two companies with regard to the contract, were calculated.

The Chairman said the amount received by each was settled between the two companies. The French company was the original company. The English company was established for the purpose of adding to the number of cables, it being found easier to raise the money in England than in France. The proportions were fixed partly in relation to capital and partly other matters. It should be remembered by those people who complained of the large dividend the shareholders were receiving now that for some time after the company was established no dividends at all were paid.

The motion was carried unanimously as was a second approving of the recommendation of the directors that a dividend for the half-year at the rate of 12 per cent. per annum should be declared, payable on and after September 1st.

The retiring directors, Sir Julian Goldsmid and the Hon. E. Chandos Leigh, Q.C., were re-elected, and the appointment of the Hon. J. S. Gathorne Hardy was confirmed. The auditors, Mr. W. R. Cole and Sir Thomas Dakin, were re-elected, and the meeting terminated.

The Direct United States Cable Company, Limited.

The report of the directors for the six months ended 30th June, 1887, to be presented at the twentieth ordinary general meeting of the company, to-day (Friday) states that the half-year's revenue (which is subject to adjustment on settlement of the pending proceedings against the French company), after deducting out-payments, amounted to £23,571 15s. 4d. against £28,445 0s. 9d. (after similar deductions) for the corresponding period of 1886, being a difference of £4,873 5s. 5d. against the half-year under review, notwithstanding a large increase in the volume of traffic carried at the sixpenny rate. This difference is entirely owing to the higher tariff in force during the first four months of 1886.

The working and other expenses for the same period, including income tax, but exclusive of cost of repairs of cables, amounted to £15,905 3s. 2d. leaving a balance of £7,666 12s. 2d. as the net profit of the half-year, making with £228 18s. 8d. brought forward from the previous half-year, and £4,246 9s. 2d. transferred from the reserve fund account a total of £12,142 0s. 0d. For the corresponding half-year of 1886 the working expenses and other payments amounted to £15,866 19s. 7d.

Three quarterly interim dividends of 2s. each per share amounting to £18,213 have been declared and paid during the financial year, and a final dividend of 2s. per share is now proposed, making, with the three interim dividends 2 per cent. for the year, being a total distribution of £24,284 0s. 0d. The interest on the reserve fund will be utilised to provide for this final dividend.

A break occurred in the short section of cable on the 4th February last, and was repaired on the 10th of March. On 3rd April the main section of cable was interrupted, and was repaired on 10th of same month. A further break in the short section took place on 13th April, and was repaired on 22nd April. The cost of repairing these three interruptions, including spare cable used, amounted to £5,223 7s. 3d. which has been charged against the reserve fund as usual.

The sixpenny tariff is still in force, and the volume of traffic shows a large increase.

The Cuba Submarine Telegraph Company, Limited.

The thirty-second ordinary general meeting of the shareholders of this company was held on Wednesday at the offices, 61, Old Broad Street, E.C., under the presidency of Mr. Joaquin de Mancha.

Mr. James Scott, the secretary, having read the notice convening the meeting,

The Chairman moved the adoption of the following report: "The gross receipts (including the balance brought from last account) amount to £21,292 19s. 6d. and the gross expenditure (including the half of the annual payment on account of the 1881 cable) to £6,552 8s. 11d. leaving a sum of £14,740 10s. 7d. to the credit of revenue account. Of this the sum of £4,500 has been added to the reserve fund, increasing that fund to £71,000. The dividend on the preference shares will absorb £3,000, and leave £7,240 10s. 7d. out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum, free of income tax, the balance, £840 10s. 7d. being carried forward to the current half-year's account. One of the harbour lengths at Cienfuegos having become worn out, a new length has been laid by Mr. Keith, the company's engineer, to take its place. The main cables have continued throughout the half-year, and are at present, in good working order."

Nearly 2000 more messages, the chairman said, had been sent this half-year than in the preceding, but people who used the telegraph were getting so clever that the increase in the receipts was only £549. The reserve fund had reached £71,000, but as there was still £21,000 to pay for the cable towards the cost of which they were making yearly contributions, it could only be reckoned as £50,000.

Mr. Low seconded the motion, which was agreed to.

Dividends of 10 per cent. on the preference shares, subject to income tax, and 8 per cent. on the ordinary shares, free of income tax, were declared, the retiring directors and the auditor were re-elected, and the proceedings terminated in votes of thanks to the board and the employés.

The Globe Telegraph and Trust Company, Limited.

THE fourteenth ordinary general meeting of this company was held yesterday (Thursday) at Winchester House, Mr. John Pender (chairman) presiding.

Mr. William Payton, the secretary, having read the notice convening the meeting,

The Chairman moved the adoption of the following report:—

"The net revenue of the company for the year, after deduction of expenses, amounts to £146,344 17s. 2d., which, with the balance of £1,564 6s. 2d. brought forward, make a total of £147,919 3s. 4d. From this amount there has been distributed the sum of £100,246 10s. 11d. in interim dividends, leaving an available balance of £47,662 12s. 5d. The directors recommend payment of a final dividend for the year of 3s. per share on the preference shares, and of 2s. 3d. per share on the ordinary shares, making, with the former distributions, a total dividend for the year of 6 per cent., less income tax upon the preference and 2½ per cent. net upon the ordinary shares, carrying forward a balance of £1,439 9s. 11d. The reduction of the dividend on the ordinary shares is attributable to the continuance during the current year of the sixpenny traffic rate by the Atlantic companies in which this company holds stocks and shares. Sixty of the shares of the German Norwegian Cable Company have been drawn and paid off at par, and the proceeds have been carried to credit of the capital account. The company has acquired 400 additional shares in the French Telegraph Company Paris to New York. By order of the High Court of Justice the preference capital of the Direct Spanish Telegraph Company was reduced from £10 per preference share to £5. In all other respects the company's investments remain the same as in last year's accounts."

Sir Daniel Gooch seconded the adoption of this report, which was unanimously agreed to.

The retiring directors, Mr. William Ford and Sir Daniel Gooch, Bart., and the auditors, Mr. John George Griffiths, F.C.A. (Messrs. Deloitte, Dever, Griffiths and Co.), and Mr. William Griffith, B.A., barrister-at-law, were re-elected, and the meeting terminated with the usual votes of thanks.

[A more detailed report of this meeting will appear next week. —EDS. ELEC. REV.]

Brazilian Submarine Telegraph Company, Limited.—The coupons of this company's Five per Cent. debentures, due on the 31st inst., will be paid on and after the 30th inst. at the Alliance Bank, Limited, Bartholomew Lane, E.C., where coupons must be left three clear days for examination.

The Eastern Telegraph Company, Limited.—This company announces that it will, on and after August 2nd next, pay the Five per Cent. debentures terminable on that day at the banking house of Messrs. Glyn Mills, Currie & Co., 67, Lombard Street, London, with the final coupon of £2 10s.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

5542. "The regeneration or production of chromic acid from exhausted battery and other solutions." D. G. FITZ-GERALD. Dated April 21. 6d. Claims:—1. The described process of electrolytically regenerating or reproducing chromic acid in solution, from the chromium salt formed by the reduction of this acid when it is used for the generation of oxygen—as in voltaic batteries, or for the production of chlorine for bleaching and other purposes. 2. The described process of regenerating or producing chromic acid in solution, from the exhausted or reduced solution of this acid when it has been employed for the generation of oxygen or of chlorine; which process consists in treating the solution with a base that will precipitate oxide of chromium (together with oxide of zinc when this is present) re-dissolving the oxide of chromium, and converting into chromic acid, by electrolysis, the salt of chromium thus obtained.

6107. "Improvements in switch boards for telegraphic and telephonic purposes." A. BROWNE. (Communicated from abroad by Dionisio Predrahita, of America.) Dated May 5. 8d. Claims:—1st. The employment of a revolving handle in combination with studs, binding screws, metallic plate and arrangement for cutting out the batteries or instruments from the circuit when the main line circuit is to be continued into one or other of the branch line circuits. 2nd. The arrangement of lever contacts and studs on strips which enables the batteries in connection with the branch circuits to be changed or exchanged.

7848. "Improvements in secondary batteries." C. SMITH. Dated June 11. 11d. Claims:—1. A plate of a secondary battery consisting of a lead frame with its compartments filled with strips of thin lead separated from each other by other substances, substantially as described. 2. A plate of a secondary battery consisting of a lead frame with its compartments filled with alternate strips of thin lead, and either asbestos paper or peroxide of lead, substantially as described. 3. The process of manufacturing the plates of secondary batteries by arranging a number of strips of thin lead separated from each other by other substances in a cramp or other device, and placing them in the compartments of a lead frame whilst under compression, substantially as described. 4. Secondary batteries, substantially as described and shown in the drawings.

7953. "Improved method of regulating currents generated by dynamo-electric generators." W. GEIPEL. Dated June 15. 8d. Claim:—The arrangement and combination of a regulator consisting of an adjustable resistance controlled and adjusted automatically by a magnet or solenoid excited by the current from the circuit, the said adjustable resistance being placed either in a series or shunt with the field magnets of the dynamo, with a sensitive relay whose magnet or solenoid is also excited by the current from the circuit, the relay being arranged to vary the attractive force with or without an additional resistance of the regulator magnet or solenoid, substantially as described and illustrated by the drawings.

8226. "Improvements in secondary batteries or accumulators." A. M. CLARK. (Communicated from abroad by A. E. Peyrusson, of Paris.) Dated June 22. 8d. Claims:—1. The employment in an electric accumulator of a liquid containing a solution of sulphate of tin or sulphate of cadmium in combination and in contact with the electrode at the negative pole, as described. 2. In electric accumulators, the construction of electrodes of a central rod and of plates, strips, wires, or points, radiating therefrom and being convergent or closer together at the inner than at the outer part, as described and represented in the drawings.

8471. "Improvements in electric lamps." H. W. RHOADS. Dated June 28. 8d. The inventor employs carbons in a circular or semi-circular form fixed in their holders in horizontal positions, and fed in opposite directions by toothed wheels on each rod and an intermediate pinion wheel between them, the shunt coils feed the lamp by means of ratchets and wheel; the arc of the lamp is struck by means of an angular or helical slot in a bush mounted on the escape wheel axle. In the axle is a pin which works in the helical slot; the top part of the bush carries a small toothed wheel, the lower part of the bush rests in the fork of the main coil armature; a spring acts on the end of the fork to throw it down when the current is off; two adjustable eccentric arms are attached to the fork to throw the ratchets out of gear when the lamp is out; also a stationary spring is mounted so as to gear into the toothed wheel on the bush in its sliding up and down action which operates the wheels opening and shutting the carbon points; the forked armature is worked by current in the main circuit. The claims are 2 in number.

8413. "Improvements in incandescent electric lamps." J. G. LORRAIN. Dated June 25. 6d. Claim:—The improvement in incandescent electric lamps, consisting in the use of bunches of separate conducting wires passing to the ends or mounts of an incandescing carbon conductor, substantially as described.

8497. "Improvements in apparatus for generating electricity." A. F. ST. GEORGE. Dated June 29. 8d. In order to produce a steady and practically unvarying current of electricity the inventor takes a long flexible ribbon, band, belt, chain, or wire of metal, or other suitable material, as hereinafter described, and he causes such ribbon, band, belt, chain, or wire to pass into a vessel containing a suitable exciting chemical solution, and to move slowly by a continuous or intermittent movement through the solution, and to pass out of it so as from time to time to cause fresh portions of the ribbon, band, belt, chain, or wire to be exposed to the chemical action of the liquid. Sometimes the inventor employs an endless ribbon, band, belt, chain, or wire for an element, and he prefers to make it progress through the solution of the cell into a separate cell containing a depolarising liquid or gas, or substance, such for instance as nitric acid or charcoal, which shall have the effect of dissipating or dissolving out the gas collected on or occluded in the ribbon or wire upon its leaving the liquid of the galvanic cell. After passing through such depolarising liquid, or gas, or substance, the ribbon or wire re-enters the galvanic cell and so on as before. The claims are 4 in number.

8739. "Improvements in electrical signalling apparatus." H. H. LAKE. (Communicated from abroad by L. Sellner, of Vienna.) Dated July 3rd. 4d. Relates to the night signalling apparatus described in the specification of letters patent dated December 8th, 1884, No. 16144. Claim:—In night-signalling apparatus of the kind hereinbefore referred to, the employment of incandescent lamps for the purpose of maintaining a constant resistance in the circuit of the generator.

10477. "Improvements in the deposition of platinum by electricity." W. A. THOMS. Dated August 16. 6d. Claim:—In the process of depositing platinum by electricity, the employment of a bath consisting of a solution of platinum in the form of a chloride, to which is added a solution of ordinary phosphate of soda, and then a solution of ordinary phosphate of ammonia, the whole being subsequently boiled, and chloride of sodium solution added, all substantially as specified.

12833. "Automatic apparatus for subjecting the person to the action of electric currents." A. LOISEAU and O. PIERRARD. Dated October 8. 8d. Relates to automatic apparatus whereby a person, mounting on a stand in connection with the apparatus, and introducing a coin into an opening therein and then grasping two projecting handles and pulling them outwards, will be subjected to the action of an electric current, the said pull causing an indication of the strength of the current, to which he is subjected to be given by a pointer on a dial. The claims are 5 in number.

14983. "Application of a solenoid for reinforcing electrical contacts." E. W. SERRELL. Dated November 18. 6d. Consists in reinforcing the actual contact between two contact pieces of an electric circuit by means of a solenoid. There is 1 claim.

15053. "Improvements in the construction of electric arc lamps." A. J. BEAUMONT. Dated November 19. 6d. Claims:—1. When the arc is struck it will maintain its arc by the current passing in two directions, first through an outer electro-magnet, and also through an inner electro-magnet, thereby causing an equilibrium, according to the drawings and substantially as described. 2. The combination of the apparatus in which the inventor does away with all rack and pinion movement, brake wheel adjustments, clutches, and all kinds of such movements, herein substantially described and according to the drawings. 3. The combination of an outer electro-magnet acting on an inner magnet when in operation, substantially as described and according to the drawings. 4. The combination to prevent the break of the current from the machine so that the carbons will come together and strike the arc, substantially as described and according to the drawings.

16739. "Improvements in electric motors and dynamo-electric machines, and processes of manufacturing the same." C. G. CURTIS, F. B. CROCKER, and S. S. WHEELER. Dated December 21. 11d. The principal objects of the invention are to simplify and greatly cheapen the cost of construction of such machines, as well as to increase the power and also the compactness of these machines. The claims are 39 in number.

17052. "Improvements in suspending overhead telegraph, telephone, and like wires." A. E. HARRIS. Dated December 29. 8d. Relates to suspending telegraph, telephone, and like wires in such a manner that they shall not be liable to be broken from the effects of the weather, and the invention consists in so joining or connecting the wires to their posts or supports that in the event of the wires contracting from the effects of cold, or by their being subjected to a weight of snow, or being acted upon by a high wind, the connections will, by being formed of a spring, or a socket and set screw, or of jointed levers, or in any other suitable manner, expand or be elongated, so as to release the wires from the strain to which they are subjected. The claims are 4 in number.

CORRESPONDENCE.

Telephone Patents.

I send you another letter, partly in reply to Mr. Barney's criticisms on my last.

I have read his with great interest, but am afraid that on one point he has unwittingly misrepresented

me. Your valued correspondent says: "I have erred in stating that the 'English Mechanic' receiver was described in Bell's patent, and was disclaimed by him."

Now I should like to know where I stated the above? If Mr. Barney would read my letter again, he cannot help seeing he has misunderstood me. I will quote from same: "He (Bell) may perhaps though have thought that his English patent would include that form of telephone (E.M.R.) as well." That is the only clause that your correspondent can lay hold of for proof of his assertion, and I think it is rather a rash conclusion to judge from it, and say that I have therefore stated that the E.M.T. was described in Bell's patent and was disclaimed by him.

Although there is no *set* description of the E.M.T. in Bell's disclaimer, yet, nevertheless, I will maintain this, viz., that it was that instrument which brought about the disclaimer. In fact, the reading causes anyone to at once infer such. Surely Mr. Barney is quite wrong in stating that the E.M.T. was *first* mentioned by Bell in his paper read before the Society of Telegraph Engineers, October, 1877. If that had been so the E.M.T. would have been sealed from the public, for Bell's patent was filed in England on December 9th, 1876. But the *English Mechanic and World of Science Magazine* had previously on August 11th, 1876, given a complete description of the instrument christened after it. Where had this paper got its information? Why, from the "States," where for the *first* time this form of telephone was exhibited by Bell at the Massachusetts Institute of Technology. There the membrane used was goldbeater's skin, and that is why the true E.M.T. should have such. Here also comes in my point, when I repeat that when we read the words of Bell's disclaimer "like goldbeater's skin," we cannot but infer that the E.M.T. is here *indirectly* referred to. There are other equally good arguments to show such is the inference. I was not aware though that ebonite, mica, or wood were membranes. What is Mr. Barney's object in submitting that the E.M.T. and Glasgow receiver are free instruments? Everybody knows that the former is free, and that the latter has also long years ago been decided by the "Court of Appeal" to be public property. I am also going to be bold enough to say that the "Glasgow receiver" is not an efficient instrument. In Mr. Barney's allusion to this telephone he causes me to smile somewhat. He says "A receiver made with an iron disc about the 16th of an inch thick and fastened firmly at one point so that it will *not vibrate as a reed or bar*, will reproduce articulate speech with more distinctness than any Bell receiver." I question the greater distinctness, but I will say that a telephone like this would be nothing more than a "Bell receiver." We all know how to make an instrument of that kind. But what takes place when voice waves are impinged on to such a diaphragm. Surely "tympanic vibration," and is this not Bell's great claim and advance over the "Glasgow receiver?" The fact, Sirs, is that we know for certain there are efficient telephones which are *legally free*. On my own part I am content for the present to abide by them, if only for the sakes of customers. We know also that there are certain telephones which we are confident are in truth *morally free*. But that's another thing from being "legally free," and it seems useless on this matter for "the weak to fight the strong." I admit that "Truth" and "Law" do shake hands occasionally, but how often that shake is like one of Society's, a cold touch with the tips of the fingers.

In conclusion, Sirs, you are aware that the Bell patent expires in a little over three years. It is an open secret that application will be made (if not done so already) for an extension of the patent. Are there no means to outsiders of opposing this extension, or is it all done in secret? The cry goes up, How long is unjust monopoly to continue? And all this through the "law" and the "mystery of definition." Is this industry, I ask, to be levelled to the dust for another long term of years without a protest of some kind being made?

John S. Ross.

July 27th, 1887.

The Calibration of Measuring Instruments.

Your columns have recently contained much interesting information as to voltmeters, but there is still no announcement of any means whereby an authoritative calibration of such instruments can be obtained. It has been expected that the Kew Observatory, where barometers, thermometers (and now chronometers) are certified, would extend the privilege to instruments for electrical testing, and the following comparisons of 7 voltmeters—simply connected consecutively to a varying number of secondary cells in series—will show the necessity for such a court of appeal.

Cells.	A		B		C		D		E		F		G	
	Volts.	Error.	Volts.	Error.	Volts.	Error.	Volts.	Error.	Volts.	Error.	Volts.	Error.	Volts.	Error.
20	38·8	− 1·3	41·4	+ 1·3	40	− 0·1	39·4	− 0·7	43·4	+ 3·3	39·2	− 0·9	40·7	+ 0·6
22	43·1	− 1·0	44·6	+ 0·5	44	− 0·1	43·2	− 0·9	47·2	+ 3·1	44	− 0·1	44·5	+ 0·4
24	46·7	− 1·6	49	+ 0·7	48	− 0·3	47·1	− 1·2	51·3	+ 3·0	48	− 0·3	48·8	+ 0·5
26	50·6	− 1·3	52·4	+ 0·5	51·7	− 0·2	51·3	− 0·6	55·5	+ 3·6	51·6	− 0·3	52·9	+ 1·0
28	54·6	− 1·8	55·8	− 0·6	56	− 0·4	55·5	− 0·9	59·5	+ 3·1	55·6	− 0·8	57·3	+ 0·9
30	58·5	− 1·3	60	− 0·2	59·5	− 0·3	59·2	− 0·6	63·4	+ 3·6	59·3	− 0·5	61	+ 1·2
32	63	− 1·0	63·2	− 0·8	63·4	− 0·6	63·4	− 0·6	67·1	+ 3·1	62·6	− 1·4	65	+ 1·0

A and B are both of the same construction by different makers. (A, new).
C and D " " " same " (D, new).
E and F " " " different " (E, new).

Two of the instruments are furnished with a (small) temperature correction, which was applied, and so was also a zero correction, where requisite. The secondary cells are large, and were in good condition, and supplied one incandescent lamp at the time of observation. This was in deference to the remark of an electrical engineer, who once told me that his voltmeters were not meant to be treated as electrometers, by direct connection to battery terminals, but should be placed in shunt to a circuit through which a current of some magnitude was flowing. I did not altogether follow the argument, though it is certain that some voltmeters do consume an appreciable quantity of current.

I have also tested these voltmeters independently, and with similar results, by Dr. Fleming's potentiometer method, so clearly explained in his "Lectures to Electrical Artisans," and in a contemporary of your own,* using, however, as standard, a Latimer Clark cell, by Elliott, in preference to the special Daniell, and a slide resistance rheostat, as being less unwieldy than the long board with stretched wires. This rheostat is of Sir W. Thomson's improved pattern, made by Messrs. White, of Glasgow, who were good enough to make for me the following modification. *Both* cylinders are of insulating material, and a third terminal is provided, from which connection can be made, by a spring contact, to the wire as it passes from one cylinder to

* *Industries*, March 4th, 1887.

the other, wherever that point may be. There are 250 turns of wire, comprising about 45 yards, and a tenth of a turn is plainly shown on the galvanometer screen. The error of the instrument C came out — 0·1 for 40 volts, increasing negatively to — 0·6 at 62, and the above tabular errors are calculated accordingly, though it is obvious that a voltmeter cannot often be read to a tenth of a division. It would be hazardous for an amateur to insist on the correctness of a problem in testing, but an error is not likely in the mere connection of voltmeters to large cells in series, and from a well-defined source of E.M.F., the indications of the several voltmeters should have agreed within narrower limits than are shown by the above table. I therefore end this letter, as it began, by hoping that a testing institution, in which all concerned may have confidence, may shortly be established.

Thomas S. Bazley.

July 25th, 1887.

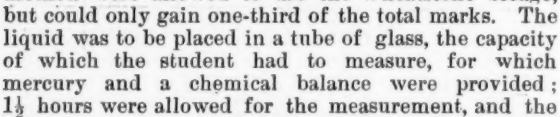
[The necessity for instruments on which one can rely is very clearly shown in Sir Thomas Bazley's letter, and we hope that something will come of it. We do not wonder that our correspondent could not follow the argument of the electrical engineer (?) who does not seem to understand the construction of electrometers.—EDS. ELEC. REV.]

Examination Papers.

The Practical Examination in Magnetism and Electricity (Honours) consisted of two questions, which, judging from the experience of myself and two others, are likely to prove fatal to most of the candidates.

The morning's work was the determination of the specific resistance of a liquid (copper sulphate) by the condenser method. Those unacquainted with this method were allowed to use the Wheatstone bridge, but could only gain one-third of the total marks. The liquid was to be placed in a tube of glass, the capacity of which the student had to measure, for which mercury and a chemical balance were provided; 1½ hours were allowed for the measurement, and the remainder of three hours for the electrical work.

The glass tube was shaped as under:



and was approximately 1 mm. in diameter, and about 35 cm. between the inner T-pieces.

To measure the resistance, we were supplied with a Grove's cell, a Wheatstone bridge (to be used as a resistance box in the required method), a high resistance mirror galvanometer, and a microfarad condenser.

Personally, I did not know the condenser method, and having no time to think it out used the bridge, finding the resistance of a column of liquid, 35·35 cm. long and ·0113 cm. in area, to be 15,520 ohms, being equivalent to a specific resistance of 4·9 ohms approximately.

In the afternoon we were required to measure the E.M.F. of a thermo-electric couple (one junction being at 20° C. and the other at 100° C.), in terms of a Daniell cell, and by either of two methods: (*a*) the potentiometer method, (*b*) by the equal deflections method—to the best of my recollection.

For the potentiometer method we were supplied with a Grove cell, a Daniell cell, and our couple, consisting of a G.S. wire with a copper wire soldered to each end, a low resistance mirror galvanometer, resistance box, and potentiometer. Owing, I imagine, to a bad contact in the resistance box supplied (an old one) I could not obtain a balance between the Daniell and Grove cells until I inserted a considerable resistance in the Daniell circuit, so that finally my results appeared as follows:

$$\text{Equilibrium} \begin{cases} \text{Grove through } 500\ \omega + \text{potentiometer wire.} \\ \text{Daniell} \quad \text{,,} \quad 320\ \omega + \frac{55}{100} \quad \text{,,} \end{cases}$$

$$\text{Equilibrium} \begin{cases} \text{Grove through } 500\ \omega + \text{potentiometer wire.} \\ \text{Thermo-electric couple through } \frac{72{\cdot}5}{100} \text{ of } \text{,,} \end{cases}$$

I had then to determine the resistance of the wire which = ·3 ω.

$$\therefore \frac{\text{E.M.F. of Daniell}}{\text{E.M.F. of given couple}} = \frac{320{\cdot}165}{{\cdot}217}$$

$$= 1475 \text{ approximately.}$$

It appears to me that a wire of the low resistance ·3 ω must in any case vitiate the whole result, since it is less than the resistance of the Daniell and probably less than that of the galvanometer.

Also the potentiometer method seems scarcely applicable to these measurements, since the ratio is more than $\frac{1000}{1}$, that is to say, that with the current from the Daniell passing through the whole wire (one metre), the proportionate length of wire for the given couple would be less than 1 millimetre, so that accuracy is practically impossible. I have yet to learn my fate from South Kensington, though I have little doubt of the result, having barely scraped through on the theoretical paper.

"Birkbeck."

July 23rd, 1887.

Information Wanted.

Can you inform me if the so-called "Eclipse" battery has ever been practically worked, and if so, by whom and where. If a patent, where lies the novelty that is to be offered to the public at such an exorbitant figure?

Is the Harris mentioned the same as Harris lately of Cheltenham Road, Bristol, who for certain reasons traded as Marsh?

Bostox.

July 23rd, 1887.

Vested Interests in Bath.

I think you are in error about the right of town councillors to vote on electric lighting questions, they being directors and shareholders of the gas company. The late Dublin Electric Light Company when I was with them had counsel's opinion on the point, and it was against your views.

Philip Jolin,
A.S.T. Eng. and M.I.M.E.

July 23rd, 1887.

Contradiction.

With reference to the paragraph in the REVIEW of 22nd inst., respecting the alleged closing of a large portion of our works and the transfer of the business of same to Germany, we beg to say that the statement is absolutely devoid of foundation, and we must request you to insert a notice to that effect in your next issue.

We must also ask you to oblige us with the name of the person from whom you obtained the information.

Regretting that you did not think it necessary to ask confirmation from us before inserting such a random statement.

Siemens Bros. & Co., Limited.
L. LOEFFLER, *Managing Director.*

July 26th, 1887.

[We are glad to insert the above letter, but Messrs. Siemens Bros. must surely have overlooked the etiquette of journalism in expecting us to reply to their second paragraph, and as regards the third, Messrs. Siemens will perhaps remember their persistent replies in the negative when we have applied to them for information on other occasions.—EDS. ELEC. REV.]